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EVALUATION OF A MULTIPURPOSE RURAL VEHICLE

FINAL REPORT prepared for TRANSPORTATION DEVELOPMENT CENTRE

April 1988

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EVALUATION OF A MULTIPURPOSE RURAL VEHICLE

FINAL REPORT

MANOP SERVICES LTD.

REID CROWTHER AND PARTNERS LTD.

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Un sommaire en français de ce document est inclus avant la table des matières.

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17. Abstract

This report presents the results of a twenty month in-service evaluation of a multipurpose rural vehicle designed to transport elderly and disabled persons and to operate as an emergency vehicle when required. The objective of the study was to evaluate the feasibility of the multipurpose concept; system operation; vehicle performance; ergonomics; and user acceptance. A multidisciplinary team of consultants carried out these evaluations.

It was found that the concept is valid and would be applicable to communities which do not have emergency services within a thirty minute travel radius. Other results were: users were satisfied with the service, typical trips being social, recreational and medical; several potential safety hazards and ergonomic deficiencies were identified in the vehicle.

The report recommends several short term and long term modifications to the prototype. Further development work for such vehicles should include substantial redesign of the front entrance and vehicle interior. Consultation with system operators and ergonomists when developing specifications and designing vehicles is recommended.

This report will be of special interest to vehicle designers and converters, and to system operators and funding agencies at the vehicle acquisition stage.

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17. Résumé

Ce rapport présente les résultats d'un programme de vingt mois ayant pour but l'évaluation en service d'un véhicule polyvalent pour régions rurales, combinant le double rôle d'ambulance et de minibus pour le transport des personnes âgées et des handicapés. Ce programme visait à évaluer l'utilité pratique du véhicule, son fonctionnement, ses performances, ses aspects ergonomiques et les réactions des usagers. L'évaluation a été faite par une équipe multidisciplinaire de consultants.

Ces essais ont validé l'idée du véhicule polyvalent qui semble surtout convenir aux municipalités rurales ne disposant pas d'un service d'intervention médicale à moins de 20 ou 30 minutes. Les usagers se sont déclarés satisfaits du service, les demandes de service ayant été faites surtout pour des motifs socio-récréatifs et médicaux. Par contre, divers points potentiellement dangereux et des faiblesses sur le plan ergonomique ont été constatés.

Le rapport formule des recommandations sur les modifications à apporter au prototype, immédiatement et à terme, y compris la réétude en profondeur de la porte avant et de l'aménagement intérieur. Il est recommandé de consulter les exploitants et de solliciter l'avis des ergonomistes.

Ce rapport intéressera particulièrement les concepteurs de véhicules, les entreprises spécialisées dans l'aménagement et la conversion des véhicules, les exploitants ainsi que les organismes de financement.

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SUMMARY

Objective and Site of the Evaluation

This project resulted from the concept of a multipurpose vehicle to fill the roles of both an emergency and a public transport vehicle for elderly and disabled persons in isolated rural communities. The objective of the Multipurpose Rural Vehicle Evaluation Project was to evaluate the in-service performance of a TDC developed multipurpose vehicle. The evaluation project was also expected to provide: valuable cost and operating experience from the testing and evaluation of the multipurpose vehicle in service; useful recommendations for equipment and operating improvements; and an evaluation of the applicability to other rural situations and sites. The test site for the multipurpose vehicle, called a "Handivan", was the Village and Rural Municipality of Minitonas, Manitoba, with a total population of 2,000 persons. The Handivan first went into service on August 28, 1986. The performance of the multipurpose vehicle has been evaluated by a team of consultants contracted for by TDC.

Vehicle Evaluated

The Handivan was based on a modified Ford Model E350 van chassis. It is capable of transporting five ambulatory passengers, or three persons in wheelchairs and two ambulatory passengers, or one person on a stretcher and one attendant at any one time. Access is provided on the right-hand side by a wheelchair lift at the rear, and folding doors at the front of the vehicle. Emergency doors are provided at the rear. For the stretcher configuration, most of the necessary paramedic equipment kits normally included in an emergency vehicle are made available for quick loading onto the vehicle.

Municipal Handivan Service

The Minitonas Handivan service is operated by a non-profit association formed jointly by the Village of Minitonas and the Rural Municipality (R.M.) of Minitonas in January, 1986. An operating Board of Directors sets service and trip priorities and user fares. Trips are accommodated within the Village and the R.M. of Minitonas and between the users' residences and destinations in the Town of Swan River some 18 kilometres to the west. The 1987 operating statistics for the service are as follows:

Annual ridership (trips)	998		
Operating cost per trip		$ 6.80	
Vehicle depreciation per trip		$ 10.07	
Total cost per trip		$ 16.87	
Revenue per trip		$ 1.09	
Revenue/total cost ratio			6%
Total cost per kilometre		$ 3.76	
Trips completed as scheduled			100%
Trips refused			0%

Under the Program for Transportation of the Mobility Disadvantaged in Rural Manitoba, the Province of Manitoba pays an operating grant of 37.5% of the cost of service. The remaining deficit is shared between the Village and the R.M.

Evaluation of Handivan Service

A quantitative evaluation of the Minitonas Handivan service by the consultants revealed that:

- the current rate of Handivan ridership is about 0.65 trips per capita, annually, compared to an average of 0.83 trips per capita for eight other Handivan services in small communities in Manitoba. This lower rate of ridership is normal for a newly-implemented service;
- operating costs are in line with other Handivan services in Manitoba;
- the revenue/cost ratio is expected to improve with a new fare schedule introduced in February, 1988.

Consumer surveys have indicated that the users are very pleased with the performance of the Handivan service and the multipurpose vehicle. The typical user is a low-income female resident of a senior's home of 65 or more years in age. Typical trips include local social/recreational travel and trips to Swan River for medical appointments and shopping.

Mechanical Evaluation

During the course of vehicle modification, it was decided, due to cost constraints and a change in operating philosophy, that several original specifications no longer applied, for example, fuel capacity. The evaluation revealed several deficiencies:

- instructions for the wheelchair securement systems were missing;
- vehicle was not completely undercoated;
- headroom was minimal;
- equipment storage space was insufficient.

Ergonomics Evaluation

This is the first rigorous ergonomics evaluation of a vehicle which has been converted to transport elderly and disabled persons. This multipurpose vehicle differs from the average converted vehicle in that it can be quickly converted into a stretcher configuration. The findings of the ergonomics evaluation, therefore, will apply in general to lift-equipped vehicles used to transport the disabled. The evaluation revealed:

- potential passenger safety hazards associated with the entrance steps, wheelchair lift, internal equipment and tools, and the regular seatings;
- potential injuries to the operator from the operation of the lift, the change-over of seats to the wheelchair configuration, and in handling the stretcher.

Conclusions

From the point-of-view of the consumers, the multipurpose vehicle is more than adequate for their current public transport needs. In the future, a vehicle with more seating capacity may be needed. To date, the stretcher configuration has not been used in actual emergency service. Such trips for medical emergencies have been made with seated passengers.

From a provincial perspective, few requests for a multipurpose vehicle are likely to be received from local governments, unless the Province promotes the option. Should this occur, the province, as a result of this study, will have more rigorous criteria to apply to site selection. The video that was produced to illustrate the operation of the Handivan can be shown to interested municipalities.

From a national perspective, the concept of a multipurpose rural vehicle appears to be valid. Multipurpose vehicles have potential application in rural municipalities which do not have emergency vehicle service within 20 to 30 minutes travel time.

The Canadian Standards Association D409 Standards for Motor Vehicles for the Transportation of Physically Disabled Persons do not include standards for application to the emergency features of the multipurpose rural vehicle. Specific standards should therefore be developed and efforts should be made to have them accepted by the provinces.

Recommendations

1. More rigorous criteria should be applied to site selection for the operation of a multipurpose rural vehicle.

2. The Province should relocate the prototype vehicle for a trial period to further test the validity of the multipurpose concept.

3. Long term modifications to the prototype should be considered. These include the installation of a softer suspension and an auxiliary fuel tank.

4. Future multipurpose vehicle development should include major inputs from system operators and ergonomists in order to eliminate potential safety hazards and to improve vehicle design. Design improvements should include: wider front entrance; elimination of uneven step heights; improved floor mounting system for removable seats; alternative seating layouts; and enhanced window treatment.

SOMMAIRE

Programme d'évaluation : objectif et site

Ce programme visait l'évaluation d'un véhicule polyvalent, combinant le double rôle d'ambulance et de minibus pour le transport des personnes âgées et des handicapés en milieu rural éloigné. Il avait pour objectif d'évaluer les performances en service d'un tel véhicule mis au point avec le concours financier du Centre de développement des transports (CDT) et de renseigner sur les aspects suivants : comportement, coût d'exploitation, perfectionnements possibles de l'équipement et des méthodes d'exploitation et aptitude à s'adapter à d'autres rôles et d'autres milieux ruraux. Le site choisi pour le programme d'évaluation du véhicule appelé "Handivan" a été la municipalité rurale de Minitonas au Manitoba, laquelle compte une population de 2000 personnes en tout. L'évaluation du véhicule qui a été mis en service le 28 août 1986 a été confiée à une firme de consultants en vertu d'un marché conclu avec le CDT.

Description du véhicule

Le Handivan est monté sur un châssis de fourgonnette Ford E350 modifié. Il peut transporter cinq passagers ordinaires, ou trois passagers en fauteuil roulant et deux passagers ordinaires, ou bien un patient sur civière avec son accompagnateur. On y accède par une plate-forme élévatrice installée à l'arrière, à droite, et par une portière à deux vantaux à l'avant. A l'arrière du véhicule, il y a aussi une sortie de secours. Pour le rôle d'ambulance, tout l'équipement paramédical nécessaire se charge rapidement à bord.

Service municipal

Le service est assuré par une association à but non lucratif fondée en janvier 1986 par le village et la municipalité rurale de Minitonas. Un conseil d'administration établit la structure tarifaire ainsi que l'ordre des priorités concernant les services offerts et les motifs de déplacement. Les déplacements se font à l'intérieur du village et de la municipalité rurale de Minitonas et s'étendent à différentes destinations dans la ville de Swan River, à quelque 18 km à l'ouest. Les résultats d'exploitation pour l'année 1987 ont été les suivants :

Nombre de déplacements	998		
Coût d'exploitation par déplacement		6,80 $	
Amortissement par déplacement		10,07 $	
Coût total par déplacement		16,87 $	
Recettes par déplacement		1,09 $	
Rapport recettes/coût total			6 %
Coût total au kilomètre		3,76 $	
Pourcentage des demandes satisfaites			100 %
Pourcentage des demandes refusées			0 %

Aux termes du programme d'aide au transport des personnes à mobilité réduite dans les régions rurales, le gouvernement du Manitoba verse une subvention d'exploitation équivalant à 37,5 p. 100 du coût des services offerts, le reste étant subventionné par le village et la municipalité rurale de Minitonas.

Évaluation générale

L'évaluation générale du service Handivan à Minitonas à montré que :

- le taux de fréquentation a été d'environ 0,65 déplacement par habitant par an, comparativement au taux moyen de 0,83 dégagé pour huit autres services Handivan, ailleurs au Manitoba. Il est normal que le taux de fréquentation d'un nouveau service soit plus faible que la moyenne générale;

- le coût d'exploitation se compare à celui des services Handivan assurés ailleurs au Manitoba;

- le rapport recettes/coût devrait s'améliorer avec la nouvelle structure tarifaire introduite en février 1988.

Une enquête auprès des usagers a révélé que ceux-ci sont très satisfaits tant du service qu'on leur offre que du véhicule lui-même. L'usager type est une femme ayant un faible revenu, âgée de 65 ans ou plus et pensionnaire dans un foyer pour personnes âgées. Les déplacements locaux ont un motif essentiellement socio-récréatif, tandis que ceux à destination de Swan River ont un motif médical ou commercial (magasinage).

Évaluation technique

Pour des raisons reliées à des contraintes financières et à un changement dans le mode d'exploitation envisagé, il a été décidé de mettre de côté certaines des spécifications initiales touchant l'adaptation du véhicule, entre autres, celle concernant la capacité du réservoir. Quant à l'évaluation technique, elle a mis en évidence les lacunes suivantes :

- absence d'instructions sur les dispositifs d'immobilisation des fauteuils roulants;
- lacunes dans la couche anti-rouille protégeant le soubassement;
- espace pour la tête insuffisant;
- espace de rangement insuffisant.

Évaluation ergonomique

Il s'agissait de la première évaluation ergonomique rigoureuse d'un véhicule converti au transport des personnes âgées et des handicapés. Le véhicule dont il s'agit se distingue des autres véhicules adaptés par le fait qu'il est rapidement convertible à la configuration ambulance. L'évaluation a donc été faite dans l'optique des véhicules équipés de plates-formes élévatrices. Elle a mis en évidence ce qui suit :

- atteintes possibles à la sécurité des passagers à cause de l'emmarchement, de la plate-forme élévatrice, de l'équipement embarqué et de l'ancrage des sièges;
- blessures possibles au conducteur lors du fonctionnement de la plate-forme élévatrice, de l'enlèvement des sièges pour faire place à des fauteuils roulants et de la manipulation de la civière.

Conclusions

Du point de vue de l'usager, le véhicule polyvalent répond de manière plus que suffisante à la demande de transports collectifs. Il se peut cependant que, à l'avenir, un véhicule de capacité assise plus grande doive être mis en ambulance service. Le véhicule actuel n'a pas encore été utilisé dans sa configuration, toutes les personnes transportées pour motif d'urgence médicale ayant fait le trajet en position assise.

Quant au gouvernement provincial, il ne doit pas s'attendre à recevoir de nombreuses demandes pour un véhicule de ce type, à moins qu'il n'en fasse la promotion. Dans ce cas, la province, grâce à la présente étude, pourra appliquer des critères rigoureux en vue de déterminer les sites d'implantation admissibles. Il pourra montrer aux municipalités intéressées le film vidéo produit dans le but d'illustrer le fonctionnement du Handivan.

Du point de vue national, l'idée du véhicule polyvalent semble justifiée, ce type de véhicule pouvant surtout convenir aux municipalités rurales qui ne disposent pas d'un service d'intervention médicale à moins de 20 ou 30 minutes.

La norme D409 de l'Association canadienne de normalisation intitulée "Véhicules automobiles pour le transport des personnes handicapées" ne comporte aucune disposition visant les équipements de secours d'un véhicule polyvalent pour régions rurales. Des normes devront donc être étudiées spécifiquement, et des efforts déployés pour les faire accepter par les provinces.

Recommandations

1. Élaborer des critères plus rigoureux pour déterminer les sites d'implantation admissibles.

2. Éprouver davantage le concept du véhicule polyvalent en prolongeant la période d'évaluation, mais dans un autre site.

3. Envisager de modifier le véhicule à long terme par l'installation d'une suspension moins dure et d'un réservoir auxiliaire de carburant, par exemple.

4. Tenir compte des réactions des exploitants et de l'avis des ergonomistes dans le but d'éliminer toutes les atteintes à la sécurité possibles et de donner au véhicule des caractéristiques améliorées. Exemples : porte avant plus large; emmarchement régulier; système d'ancrage au plancher pour les sièges amovibles; différentes possibilités de disposition des sièges; fenêtres mieux étudiées.

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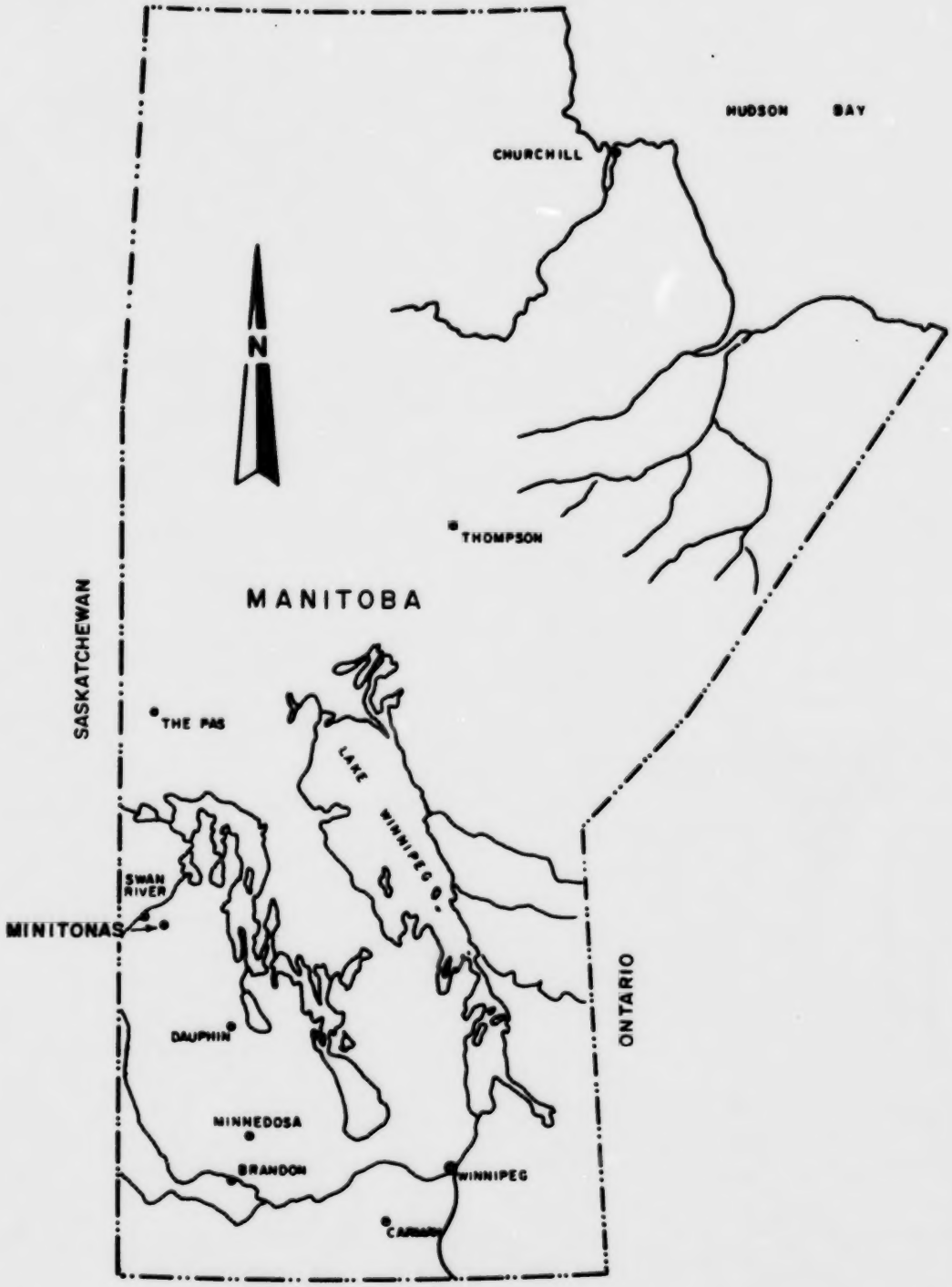


Figure 1.1
Provincial Map Showing Location of Minitonas

1.0 INTRODUCTION

1.1 Background

This project resulted from the concept of a multipurpose vehicle to fill the roles of both an emergency and a transportation vehicle for elderly and disabled persons in isolated rural communities. The need for such a vehicle had been recognized by the Government of Manitoba and by Transport Canada for application to small communities that could not support both dedicated ambulance service and public transport for the disabled.

In fiscal year 1985-86, a Transportation Development Centre (TDC) project was carried out under contract by TES Ltd. of Ottawa to develop mechanical specifications, acquire a vehicle, carry out suitable modifications, outfit it with specialized emergency equipment and develop a demonstration plan.(1) Emergency Vehicle Specifications were provided by the Manitoba Health Services Commission. The TDC project determined that a design based on an existing commercial vehicle would provide the simplest and most cost-effective solution.

The vehicle was acquired, modified, and equipped and gratuitously transferred to the Province of Manitoba, which in turn gratuitously transferred the vehicle to the Rural Municipality of Minitonas. Under the Program for Transportation of the Mobility Disadvantaged in Rural Manitoba, the Rural Municipality and Village of Minitonas, located in the "Parkland Region" of Manitoba, was selected as the in-service test site.(2) (See Figure 1.1 opposite.) Provision was made for a two-year in-service evaluation that was expected to provide useful recommendations for equipment and operating improvements, and establish the potential applicability to other rural situations and sites. A Steering Committee representing the three levels of government concerned with the performance of the vehicle guided the evaluation process.

1.2 Vehicle Evaluated

The multipurpose vehicle, called a "Handivan", was based on a modified Ford Model E350 van chassis. It is capable of transporting five ambulatory passengers, or three persons in wheelchairs and two ambulatory passengers, or one person on a stretcher and one attendant at any one time. Access is provided on the right-hand side by a wheelchair lift at the rear, and folding doors at the front of the vehicle. Emergency doors are provided at the rear. For the stretcher configuration, most of the paramedic equipment kits normally included in an ambulance are made available for quick loading onto the vehicle.

The Handivan was provided to the community of Minitonas in the summer of 1986 and first went into service on August 28, 1986. The performance of

(1) Numbers in brackets designate references listed on page 41 of the report.

the Handivan in public transport service has been evaluated by a team of consultants contracted for by TDC.

1.3 Project Objective

The objective of the Multipurpose Vehicle Evaluation Project was "to evaluate the in-service performance of a TDC developed multipurpose rural vehicle."(3) The evaluation project was expected to provide: valuable cost and operating experience from the testing and evaluation of the multipurpose vehicle in service; useful recommendations for equipment and operating improvements; and an evaluation of the applicability to other rural situations and sites.

1.4 Steering Committee

The evaluation project was guided by a Steering Committee made up of representatives of the following organizations:

- Transportation Development Centre
- Manitoba Department of Highways and Transportation
- Manitoba Health Services Commission
- Rural Municipality of Minitonas
- Village of Minitonas

1.5 Organization of the Report

The balance of the report is organized as follows:

Chapter 2 contains a detailed description of the municipal transport system within which the Handivan is deployed.

Chapter 3 presents an evaluation of the performance of the transport service described in Chapter 2.

Chapter 4 presents a comparison of the original mechanical specifications for the multipurpose rural vehicle with the modified production vehicle that was delivered.

Chapter 5 contains the ergonomics evaluation of the multipurpose rural vehicle.

Chapter 6 contains the consultant team's conclusions and recommendations for future applications of multipurpose vehicles.

2.0 DESCRIPTION OF MUNICIPAL HANDIVAN SERVICE

2.1 Organization and Administration

The Minitonas Handivan service is operated by a non-profit association that was formed jointly by the Village of Minitonas and the Rural Municipality (R.M.) of Minitonas on January 9, 1986.(4) The R.M. and Village of Minitonas Handivan Association has an operating Board of six Directors. Three Board members are appointed by the Village and three by the Rural Municipality. The Board normally meets on the evening of the fourth Wednesday of each month. The Board has three representatives on the Steering Committee for the Multipurpose Vehicle Evaluation.

For the purposes of financial control, the affairs of the Association are administered through the Rural Municipality which is the registered owner of the multipurpose vehicle. The Secretary-Treasurer for both the Village and the Rural Municipality acts as Secretary to the Association.

2.2 Advisory Committee

In February, 1986, the Board of Directors invited all local church organizations and service clubs to appoint representatives to an Advisory Committee. This resulted in a nine-person Committee being established to advise the Board on community travel needs and service experience. The Committee normally meets on the same dates as the Board.

2.3 User and Service Priorities

The Board of Directors established the user and service priorities on February 17, 1986. The eligible users in order of priority were established as follows:

- persons using wheelchairs;
- semi-ambulatory persons;
- persons with impaired vision;
- all other handicapped persons;
- senior citizens.

Trips to be accommodated by the service in order of priority included:

- emergency medical trips;
- work trips;
- routine medical trips;
- trips for educational purposes;
- personal business, social and recreational trips.

Trips are accommodated within the Village and the R.M. of Minitonas and between the users' residences and destinations in the Town of Swan River some 18 kilometres to the west (see Figure 2.1).

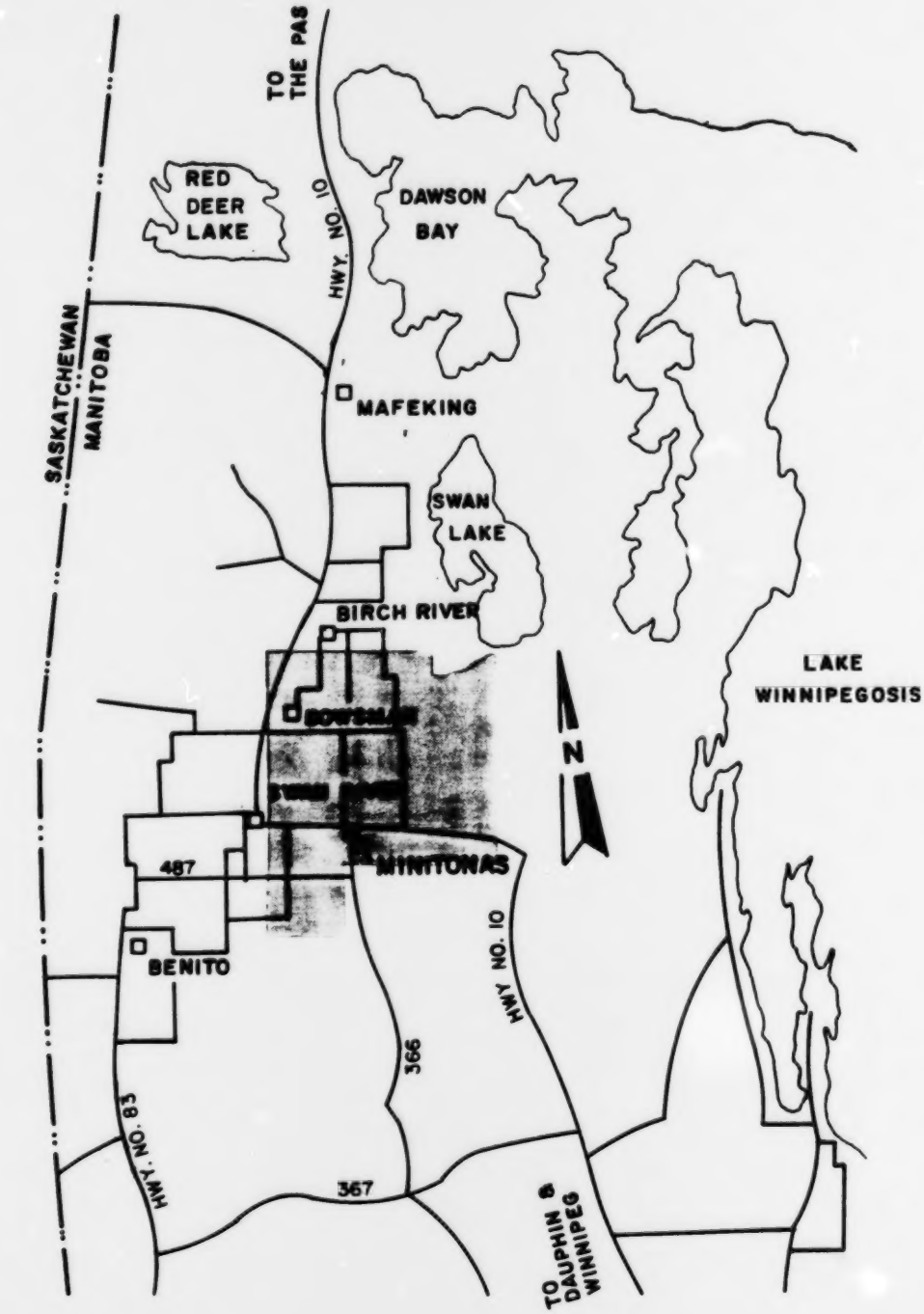


Figure 2.1

Regional Map Showing Communities Served

2.4 Initial Fares and Service Charges

The following user fares, established by the Board in April, 1986, were in effect when service began in August, 1986:

* 1 passenger - $2.00 plus $0.20 per kilometre;
* 2 passengers - $1.50 each plus $0.17 per kilometre;
* 3 passengers - $1.25 each plus $0.15 per kilometre;
* 4 passengers or more - $1.00 each plus $0.12 per kilometre.

The kilometre charges were applied only to trips outside the Village of Minitonas.

The following rates were in effect for emergency vehicle service:

* basic trip - an overall charge of $37.35 plus $0.45 per kilometre plus attendant fees which varied from $15.00 to $19.00 depending upon the distance travelled (this was 3/4 of the regular ambulance rate in effect at the time);
* hospital to airport (3 km) - $54.00 plus attendant fees.

On September 15, 1986, the Board reduced the above fares by 50% effective December 1, 1986. These half-price fares remained in effect until January 31, 1988.

2.5 Revised Fares and Service Charges

The existing fare system was found to be confusing to the users. After some discussion with the Steering Committee on September 17, 1987, the Board decided to revise the fare schedule.

New flat rate fares based on a zone system became effective on February 1, 1988. These were as follows:

* within the Village - $2.00 per passenger;
* trips of 3 to 19 kilometres - $6.00 per passenger;
* trips of 20 to 25 kilometres - $10.00 per passenger;
* trips of 36 to 53 kilometres - $14.00 per passenger.

Senior citizens, aged 65 or more, were provided with service at a charge of 50% of the above rates. Since the majority of users are 65 or more years of age, the average revenues are about 55% of the above rates. Long distance trips were priced at $50.00 plus $0.63 per kilometre ($1.00/mile).

2.6 Driver Compensation

Because of the low frequency of usage of the Handivan, the driver is not paid a salary. The driver is paid a retainer of $50.00 per month plus a "commission" equal to the basic fares plus a portion of the distance charges. Since kilometre charges occur only outside of the Village, the driver receives all of the revenues for the local trips. Compensation for trips outside the Village was originally as follows:

* 1 passenger - $2.00 plus $0.12 per kilometre;
* 2 passengers - $1.50 each plus $0.09 per kilometre;
* 3 passengers - $1.25 each plus $0.07 per kilometre;
* 4 or more passengers - $1.00 each plus $0.06 per kilometre.

For emergency service, the driver and the ambulance attendant were each to be paid the following fees per trip:

* Village of Swan River - $15.00;
* R.M. of Swan River - $17.00;
* Cowan to Swan River - $19.00;
* hospital to airport - $17.00.

A revised driver compensation formula became effective with the revised fares on February 1, 1988. These were as follows:

* within the Village - $2.00 per passenger;
* trips of 3 to 19 kilometres - $4.50 plus $2.00 per passenger;
* trips of 20 to 35 kilometres - $6.50 plus $2.00 per passenger;
* trips of 36 to 53 kilometres - $8.50 plus $2.00 per passenger.

For typical long distance trips, the driver would be paid as follows:

* Dauphin, Manitoba - $40.00;
* Yorkton, Saskatchewan - $50.00;
* Brandon, Manitoba - $75.00;
* Winnipeg, Manitoba - $110.00.

2.7 Communications System

Passengers requiring service were able to arrange for travel by telephoning the home of the vehicle driver. The Handivan was equipped with a private frequency 2-way radio which can communicate with a station in the Town offices during the hours of 8:30 a.m. to 4:30 p.m.

2.8 Emergency Vehicle Service

To date, the Handivan has been used at least twice in emergency service for semi-ambulatory persons not requiring the use of the stretcher. In the future, there are at least three potential applications of the multipurpose vehicle in the stretcher configuration. These include:

- emergency ambulance service;
- non-emergency ambulance service;
- regional mutual aid support.

Since Minitonas has access to a good ambulance service located nearby in the Town of Swan River, provided under mutual aid agreements with the adjacent municipalities, the use of the Minitonas Handivan as an emergency ambulance is not anticipated. Such an application would be more likely in remote communities lacking an ambulance service. The only likely need at the present time for emergency ambulance service would be as a back-up for the existing ambulance service in the more remote areas of the Municipality. What is most likely is that the multipurpose

vehicle will be used to transfer stretcher passengers between medical facilities and other institutional care facilities on a non-emergency basis. In the case of disaster planning under the mutual aid agreements, the Minitonas Handivan would become an additional support vehicle. The multipurpose vehicle could then be employed as follows:

- as an evacuation vehicle;
- as a back-up ambulance if the existing ambulance service was fully committed elsewhere;
- as a first-aid station.

To accommodate such disaster planning, the existing ambulance drivers in Swan River should become familiar with the multipurpose vehicle. The Handivan was evaluated in simulated ambulance service during the Ergonomics Evaluation in Chapter 5.

2.9 Trip Generation

A graph showing the total monthly ridership since the service was first introduced is located in Appendix C-1. The ridership experienced a decline in the summer months of 1987. This trend is normal for small transit systems. Ridership increased in February, 1988, due to cold weather.

Most of the ridership is being generated by residents of the Village. It is expected that the Rural Municipality will generate more ridership in the future. However, ridership will likely remain proportionately higher for the Village due to the substantial numbers of retired residents (35%).

2.10 Trip Purposes

A graph of "Monthly Ridership by Trip Type" (see Appendix C-2) indicates that the relative proportion of recreational trips is decreasing while the proportion of trips for medical purposes is increasing. This shift in trip purpose indicates greater confidence in the Handivan service for trips of a more critical nature in the event of a service failure.

2.11 Trip Lengths

The records of trip kilometres indicate that trip lengths are increasing. This is a result of an increased number of recreational trips to destinations within the Rural Municipality. The graph of "Total Monthly Kilometres" (see Appendix C-3) illustrates this trend. In spite of decreasing ridership in the summer months of 1987, the kilometres travelled continued to increase. Average trip lengths in June through December, 1987, were about 4 to 5 kilometres compared to 2 to 3 kilometres in January through March, 1987.

2.12 Annual Revenues and Expenditures

Table 2.1 presents the 1987 actual revenues and expenditures compared with the 1987 and 1988 budgets.

Table 2.1

Annual Revenues and Expenditures
for Handivan Service

	1987 Budget	1987 Actual	1988 Budget
Revenue:			
User fees	$ 600.00	$ 1,089.00	$ 1,500.00
Province of Manitoba operating grant	7,000.00	6,241.00	6,000.00
Village of Minitonas	2,500.00	1,500.00	2,000.00
R.M. of Minitonas	3,500.00	1,500.00	2,000.00
Donations	1,000.00	-	-
Fund raising	1,000.00	-	500.00
Interest	-	171.00	-
Total Revenue	$15,600.00	$10,501.00	$12,000.00
Expenditures:			
Wages and benefits	$ 1,000.00	$ 2,722.00	$ 3,000.00
Gas and oil	500.00	1,028.00	1,000.00
Repairs and maintenance	500.00	371.00	250.00
Licences and insurance	800.00	919.00	1,200.00
Depreciation (1)	11,000.00	9,854.00	9,854.00
Radio licences	200.00	108.00	108.00
Office supplies	50.00	50.00	50.00
Professional fees (audit, legal)	200.00	330.00	200.00
Telephone	300.00	261.00	292.00
Administration	1,000.00	1,000.00	1,000.00
Reserve for bad debts	50.00	-	-
Total Expenses	$15,600.00	$16,643.00	$16,954.00
Deficit: (2)	-	$ 6,142.00	$ 4,954.00

(1) Assumes straight-line depreciation over 5 years.
(2) Funds are drawn from depreciation account.
(3) From projected pass sales.

3.0 EVALUATION OF HANDIVAN SERVICE

3.1 Evaluation Criteria

The consultants used two methods of evaluating the system:

- a quantitative evaluation using system targets based mainly on experience in other Manitoba communities;
- a qualitative evaluation based on user surveys conducted in November, 1987.

System targets were developed by the consultant and then discussed with the Steering Committee at the meeting held in Minitonas on September 17, 1987.

The adopted 1987-88 system targets for the quantitative evaluation (excluding any ambulance services) were as follows:

- annual ridership	1,300 trips;
- operating cost per trip	$9.00;
- vehicle depreciation per trip	$3.00;
- total cost per trip	$12.00;
- revenue per trip	$1.00;
- revenue/cost ratio	8%;
- total cost per kilometre	$3.50;
- trips completed as scheduled	97%;
- trips refused, not more than	2% (of requested trips).

3.2 Quantitative Evaluation

Table 3.1 presents a comparison of the selected targets with actual experience in Minitonas to December 31, 1987, and projections for 1988 based on experience to March 31st, for the above criteria. Table 3.2 presents comparative 1987 data for Handivan services in other small communities in Manitoba.

(a) Ridership: Current average ridership for the eight Handivan services listed in Table 3.2 is about 0.83 trips per capita annually. This compares with an estimated rate of 0.65 trips per capita annually for Minitonas by year-end 1988. This lower rate of ridership is normal for a newly-implemented service.

There is no doubt that in some cases the fares charged can affect ridership. Minitonas experienced an eight-fold increase in ridership when half-price fares were introduced in December, 1986 (see Appendix C-1).

Examples of Handivan fares in other Manitoba communities, indicate that in a range of from $0.75 to $1.50 the absolute fares are not the only factor affecting ridership.(6) Most Handivan services have a flat rate system within the community and a flat rate plus distance outside the community.

Table 3.1

Comparison of Targets with Operating Experience in Minitonas

	1987-88 Target	1987 Actual	1988 Projected
Population served	2,000	2,000	2,000
Annual ridership (trips)	1,300	998	1,300
Operating cost per trip	$9.00	$6.80	$5.15
Vehicle depreciation per trip	$3.00	$10.07	$7.58
Total cost per trip	$12.00	$16.87	$12.73
Revenue per trip	$1.00	$1.09	$1.53
Revenue/total cost ratio	8%	6%	12%
Total cost per kilometre	$3.50	$3.76	$3.50
Trips completed as scheduled	97%	100%	98%
Trips refused, not more than	2%	0%	2%

Table 3.2

Comparative 1987 Data for Other Handivan Services in Manitoba (5)

	Glenboro	Argyle	Brokenhead	Minnedosa
Population served	1,600	1,420	5,500	2,600
Annual ridership	778	1,115	4,514	578
Operating cost per trip	$6.10	$4.36	$3.50	$6.85
Vehicle depreciation per trip	$11.76	$5.41	$1.39	$9.79
Total cost per trip	$17.86	$9.77	$4.89	$16.64
Revenue per trip	$1.61	$1.10	$1.99	$4.56
Revenue/total cost ratio	9%	11%	41%	27%
Total cost per kilometre	$2.40	$2.85	$1.00	$2.16
Trips completed as scheduled	100%	100%	100%	100%
Trips refused	0	0	0	0

	Boissevain	Deloraine	Pilot Mound	Winnipegosis
Population served	2,600	2,800	2,600	1,900
Annual ridership	4,858	2,164	1,254	2,213
Operating cost per trip	$1.94	$5.09	$5.73	$4.39
Vehicle depreciation per trip	$1.03	$3.54	$5.78	$2.70
Total cost per trip	$2.97	$8.63	$11.51	$7.09
Revenue per trip	$1.42	$2.55	$1.55	$1.76
Revenue/total cost ratio	48%	30%	13%	25%
Total cost per kilometre	$0.90	$0.84	$1.30	$0.86
Trips completed as scheduled	100%	100%	100%	100%
Trips refused	0	0	0	0

(b) Operating Cost Per Trip: The operating costs per trip are in line with other Handivan services in Manitoba.

(c) Total Cost Per Trip Versus Depreciation: The total cost per trip is affected by the straight-line method currently used to depreciate the vehicle (see Table 2.1 on page 8). The original cost of the vehicle in 1986 was $49,269. Alternatively, using a commercial depreciation rate of 30% on the depreciated balance from the previous year, the depreciation would be as follows:

- 1986 $ 7,390.00 (6 months)
- 1987 $12,564.00
- 1988 $ 8,794.00

Applying the above formula would reduce the total cost per trip by about $1.00 in 1988.

(d) Revenue per Trip: This is on target and will likely improve further in the fall of 1988 due to the new flat rate fares introduced in February, 1988 (see Section 2.4).

(e) Revenue/Total Cost Ratio: This will likely exceed the target in 1989. For the months of January and February, 1988, it was on target using the old fare schedule.

(f) Total Cost per Kilometre: The cost per kilometre is also affected by the depreciation rate. Considering that trip lengths are increasing, the service is performing very well.

(g) Trips Completed/Refused: In discussions with the regular operator in February, 1988, it was indicated that all local trips had been completed and none refused.

3.3 Qualitative Evaluation

Two consumer surveys were carried out by the consultants:

- a "Special Needs Survey" was mailed with the annual tax notices to about 900 Village and R.M. taxpayers in April, 1987, to promote consumer awareness of the service being offered;
- service evaluation interviews were carried out in November, 1987.

(a) Special Needs Survey: In spite of the substantial mailing and publicity in the local newspaper, the response to the survey was very limited. A total of 16 survey forms were returned to the Municipal Office. Because the survey was designed to solicit response from households that could contain a disabled person in need of service, the low response may simply indicate that there are not very many disabled persons in the community. In any case, the response received indicated that:

- there was an awareness of the service;
- there was a perception by the general population that the service was only for the disabled;

- the service was well accepted as a standby service or as a back-up to provide transportation; and
- a typical perception was that: "Fortunately we don't have a disabled person in our household who needs such a service!"

Since the Handivan service was being used by a varied clientele, there was an awareness, at least by the existing users, that the service was not exclusively for the disabled. Those persons actually using the service either did not respond to the survey or were not the "taxpayers" and therefore did not receive the questionnaire. The response received indicated that a more personal approach needed to be taken with subsequent surveys.

(b) Service Evaluation Interviews: A total of 17 regular users of the service were interviewed using the format contained in Appendix B of this report. All of these persons are ambulatory and semi-ambulatory residents of the Village of Minitonas. There are two residents who use wheelchairs for mobility, but they are not regular users of the service and were not available for interview. Detailed user statistics from the service evaluation interviews are presented in Table 3.3.

A total of four system advocates were also interviewed using pages 3 and 4 of the interview format (see Appendix B). These numbers were not sufficient to tabulate or statistically analyze. None of the system advocates are disabled. All expressed a very high rating of the Handivan system.

3.4 Community Needs and Service Potential

(a) Community Demographics: The 1987 population estimates of the Village and the R.M. of Minitonas and the percent aged 65 or more are as follows:

	Population	% 65+
Village	628	35%
R.M.	1,369	20%
Total Community	1,997	25%

(b) Current Trends: Although there have been several inquiries about long distance trips, to cities such as Brandon for example, to date no such trips have been made. The demand pattern has been to serve social and recreational travel needs within the boundaries of the Village and the R.M. and to provide an increasing number of trips to shopping and medical facilities in the Town of Swan River.

(c) Future Needs: As the Minitonas community ages and the incidence of seniors and other persons using mobility aids (including wheelchairs) increases, the need for the multipurpose features of the Handivan will increase. The recent provision of a lift-equipped vehicle in nearby Swan River (without the stretcher option, but with more seating capacity) suggests that the two communities could pool their equipment to best serve any special needs.

Table 3.3

Results of the Service Evaluation Interviews

Trip Purposes by Destination:	Village	Town	Rural	Total
Medical	-	29%	-	29%
Shopping	11%	26%	-	37%
Recreation	17%	-	17%	34%
Total	28%	55%	17%	100%

Frequency of Use:	Users
Three (3) return trips per week	1
Two (2) return trips per week	5
One (1) return trip weekly	1
Four (4) return trips per month	2
Two (2) return trips per month	5
One (1) return trip per month	2
Five (5) return trips per year	1

Advance Notice to Travel:	Users
Same day	7
24 hours	9
One or two days	1

Trip Lengths:	Users
5 minutes	6
15 minutes	2
20 minutes	8
Unknown	1

User Travel Options:	Users
Self-drive	4
Auto Passenger	10
Bicycle	2
Walk	3
Not able to Travel	11

(Total is more than 17 because some users have more than one option.)

Reasons for Using Handivan:	Users	%
No car available/convenience of service	11	64%
Weather conditions/convenience of service	3	18%
Convenience of Service	3	18%

Residence: (all in the Village of Minitonas)	Users	%
Single Family	11	64%
Senior Citizen's Home	6	36%

Disabilities:	Users	%
Vision	1	
Hearing	2	29%
Mobility Aid	2	

Table 3.3 (continued)

Age Categories:	Users	%
Age 45 - 64	2	12%
Age 65 or over	15	88%

Sex:	Users	%
Male	4	24%
Female	13	76%

Income Levels:	Users	%
$5,000 to $10,000	15	88%
$10,000 to $20,000	2	12%

4.0 REVIEW OF VEHICLE DESIGN AND MECHANICAL SPECIFICATIONS

The original specifications for the prototype multipurpose rural vehicle were developed in 1985-86 by TES Limited of Ottawa, Canada, for TDC. These specifications were developed after discussions with Government of Manitoba representatives and TDC personnel. Emergency vehicle specifications were obtained from the Manitoba Health Services Commission to assist in defining the requirements for a multipurpose rural vehicle. It was determined that a design based on an existing commercial vehicle would provide the simplest and most cost-effective solution. It was concluded that the interior arrangement should be easily and quickly convertible to provide a combination of wheelchair positions and seats for the handivan role or a cot and seat for the stretcher configuration as shown in Figures 4.1 and 4.2, which are reproduced from the TES report. (1)

The vehicle was modified by using a Ford E350 van chassis. It is capable of transporting five ambulatory passengers, or three persons in wheelchairs and two ambulatory passengers, or one person on a stretcher and attendant at any one time. Access is provided by a wheelchair lift on the right-hand side at the rear and folding doors at the front of the vehicle. For the stretcher configuration, most of the necessary equipment and kits normally included in an ambulance are either carried in the vehicle or are available, for quick loading onto the vehicle.

4.1 Design Considerations

The intended multipurpose role of the Handivan vehicle presented several design challenges. As a local transit or paratransit vehicle, operating speeds would be low and doors would be operated more frequently than for privately owned or institutional vehicles. Modified vans used for transit service are equipped with transmission and differential gearing designed for slow-speed operation. Other components, such as the electrical and heating systems, needed to be larger.

As a vehicle for the disabled, the seating configurations were modified and ride comfort and safety considerations increased. Evacuation of the vehicle in an emergency became more critical.

For inter-community service, the handling and ride characteristics at higher speeds were important. Differential gear ratios could be higher for this service providing that the weight of the vehicle did not adversely affect its acceleration.

As an ambulance, the higher speed handling characteristics and the usable fuel capacity were more critical. Vehicle reliability considerations became more important to prevent a breakdown in service.

In addition, some compromises had to be accepted based on what was available from vehicle suppliers within the budget provided to TES. As a result, some deviations from the original specifications were accepted.

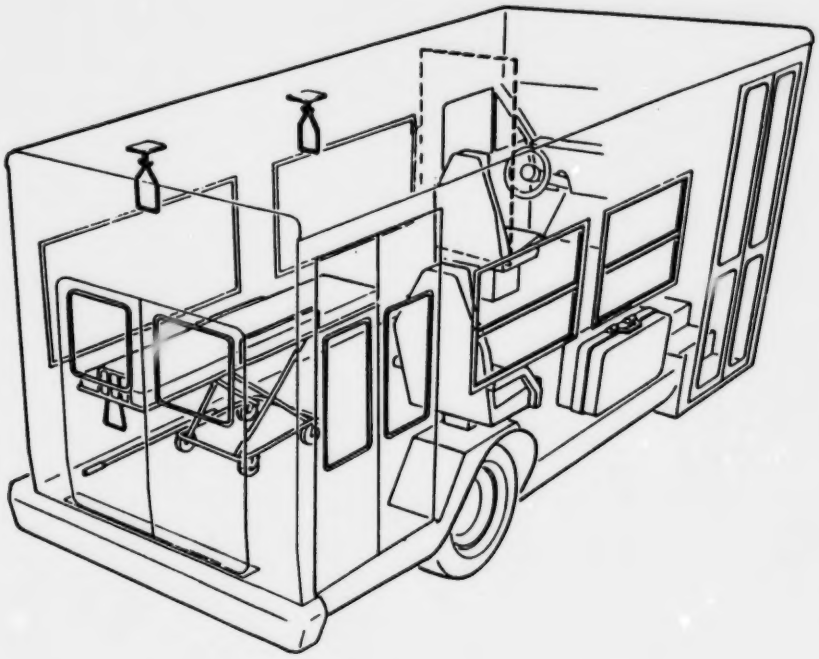


Figure 4.1 Stretcher Configuration for Handivan

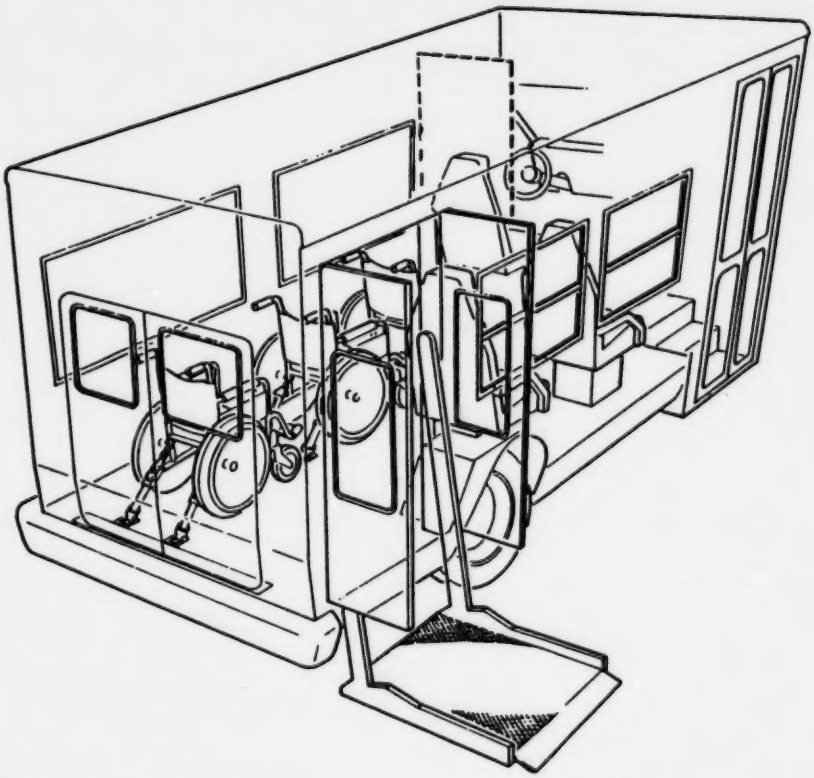


Figure 4.2 Wheelchair Configuration for Handivan

4.2 Vehicle Certification

The following vehicle certification data was provided by the manufacturer of the multipurpose vehicle supplied to Minitonas.

The chassis is a 1986 Ford Econoline Club Wagon.
The Vehicle Identification Number (VIN) supplied by A. Girardin Inc. contains the following information:

- Feb. 1986 GIRARDIN CORP.
- GVWR: 4309 kg (9500 lb.) (same as Ford)
- Front axle: 1542 kg (3400 lb.)
- Rear axle: 2875 kg (6338 lb.) (Ford spec. is 2765 lb.)
- Tires: 9:50 x 16E
- Wheels: 16.5 x 6.75 (radial wheels)
- Tire pressure: Front 345 KPa (50 psi)
  Rear 518 KPa (75 psi)
- Serial No.: 1FDJE34H5G HB07897B8
- Body Code: 9M E341 33G
- Girardin Model: 62-0832
- Timing: 10^{o} advance at 900 rpm

The vehicle was weighed empty on the scales at the Pool Elevator in Minitonas and compared to Girardin specifications on March 26, 1987. The results were as follows:

- Odometer reading: 5154 km
- Fuel: full
- Equipment: one wheelchair and the original large oxygen tank
- Passengers: none
- Seating: standard configuration

	Capacity	Weight	Available Payload
GVWR	4309 kg	3360 kg	949 kg (2088 lb.)
Front Axle	1542 kg	1150 kg	392 kg (862 lb.)
Rear Axle (Ford)	2765 kg	2190 kg	575 kg (1265 lb.)

4.3 Vehicle Performance and Suitability

The vehicle performs well as a public transit vehicle operating in a rural area. It is sufficiently powered and durable for this purpose. The vehicle is less suitable for the longer inter-urban trips where stability at higher speeds and passenger comfort become more critical.

The use of the multipurpose vehicle in the stretcher configuration for a non-emergency service is feasible in the Minitonas community. Such service could include, for example:

- transfers between private residences, the airport, care homes, and the hospital in Swan River on a non-emergency basis;
- accommodation of pre-scheduled visits to outpatient services or the doctor's office for individuals with severe disabilities;
- transfers to the regular ambulance or air service to Winnipeg from remote areas of the Rural Municipality.

The option of using the stretcher configuration presents a unique advantage. Most systems for the disabled in Canada are unable to accommodate stretcher passengers. Requests from doctors' offices for such a service are not unusual following outpatient treatment. Most system operators have to refer such requests to ambulance companies. The Minitonas Handivan service could likely respond to such needs.

4.4 Review of Specifications

Table 4.1 presents a comparison of the vehicle as supplied to the original specifications. Several of the items noted under the column "Deficiency, If Any" are discussed further in the following Chapter 5 entitled "Ergonomics Evaluation". The following subsections deal with the major areas of concern with respect to the mechanical specifications.

(a) Chassis Specification: The Handivan is built on a rugged truck chassis that is designed to carry the total weight of the vehicle and its passengers. Unfortunately, the components that ensure strength and durability of the vehicle chassis contribute to the harsh ride characteristics that are typical of this type of modified truck chassis. There are "after-market" devices, including air 'springs', that could be used to improve the ride characteristics of the vehicle, but these were not specified.

(b) Body Specification: The body that was selected for this vehicle is not the appropriate body option for the transport of adult passengers. The body selected is a low-priced school bus design with the windows located much lower than in a public transit style. The manufacturer has installed premium quality seat cushions to mitigate the harsh ride noted above. These are of no benefit to persons in wheelchairs unless they can transfer to a seat in the Handivan.

(c) Body Safety: The lack of inside storage space is a serious problem. The manufacturer has taken a standard vehicle design and modified it by 'bolt-on' additions that are not integrated into the total body design. Some of these modifications present hazards to the passengers.

(d) Emergency Usage: The Handivan is not a good vehicle for regular emergency vehicle service. It is at best a back-up vehicle to an ambulance service. There are several reasons for this, including:

- The Handivan is only equipped with a single 72 litre fuel tank, which, given its average fuel consumption rate of about 34 litres per 100 kilometres, gives it a maximum operating range of about 200 kilometres. For example, a trip to Winnipeg (about 400 kilometres) could require refuelling twice enroute.

- The Handivan is not as stable at highway speeds or as comfortable as a vehicle designed solely for emergency purposes.

Table 4.1
Specifications Versus Vehicle Supplied

1.0 CHASSIS	ORIGINAL SPECIFICATION	VEHICLE SUPPLIED MEETS SPECS.	DEFICIENCY IF ANY	COMMENTS
a Alternator	- Heavy duty 100A	Yes		- Inaccessible - verified by manufacturer
b Battery	- Two 550A in parallel with selector switch - Easily accessible - Well vented	No	- No selector switch (minor item)	- All other items as per spec.
c Block Heater	- Two with motorhome type junction on or above front bumper	Yes	- No motorhome junction	- All other items as per spec.
d Brakes	- Power assist, lines and booster assist lines protected	Yes		
e Bumpers:				
- Front	- To extend beyond body and of sufficient strength to permit pushing of vehicle	Yes		
- Rear	- Same as front - Full width step for rear door only	No	- Rear entry step 1067 mm (42") only	- Rear door width 1372 mm (54")
f Cooling System	- Largest available rad and fan, thermostatically controlled - Coolant to -35°C	Yes		
g Engine	- 5.8 L (350 CID), V8, regular gasoline - Capable of ascending and descending 40% grade 0 - 65 km/h in 8 - 11 sec.	Yes		- Performance not checked on extreme grades
h Exhaust System	- Discharge to left side of body - Adequate clearance from flammable material	Yes	- originally "no"	- relocated by dealer
i Frame	- Frame length to be unaltered - No additional holes in flanges	Yes		

Table 4.1 cont'd.

1.0 CHASSIS (cont.)	ORIGINAL SPECIFICATION	VEHICLE SUPPLIED MEETS SPECS.	DEFICIENCY IF ANY	COMMENTS
j Fuel Range and System	- Range to be 400 km (250 miles) - Lockable gas cap - Each tank equipped with separate gauge	No	- Single tank only - poor mileage (32 - 36 L/100 km)	- Limited range on single tank (220 km) (accepted by purchaser)
k Gross Vehicle Weight	- Gross axle and gross vehicle weights not to exceed manufacturer's specification	Yes		- Adequate load capacity
l Horn	- Two to be provided	Yes		
m Instrument Panel	- Speedometer, odometer, ammeter, oil pressure, fuel gauge(s), clock, accessible for repair and clearly visible	Yes		- As only 1 gas tank, only one gas gauge was supplied
n Rear Axle Ratio	- As specified by manufacturer	Yes		
o Steering	- Power steering	Yes		
p Steering Wheel	- Minimum 50 mm (2") between wheel rim and cowl, instrument panel, windshile or other surface	Yes		
q Tires and Rims	- Steel belted radials LT235/85R16, heavy duty rims, spare tire and rim in accessible location	Yes	- Spare tire on rear door limits door swing	
r Transmission	- 3-speed heavy duty automatic c/w cooler	Yes		
s Wheel Wrench and Jack	- One of each required	Yes	- No proper storage for these items	
t Undercoating	- Entire underside to be undercoated	No	- Rear of chassis extension poorly undercoated	
u Shock Absorbers and Suspension	- Double acting, heavy duty, front stabilizer bar - Rated capacity in excess of design load	Yes		- Left front shock leaking

Table 4.1 cont'd.

2.0 BODY	ORIGINAL SPECIFICATION	VEHICLE SUPPLIED MEETS SPECS.	DEFICIENCY IF ANY	COMMENTS
a Ambulatory Entrance	- Double leaf doors on right side, powered or manually operated - Locking and unlocking by operator in seated position - Doors equipped c/w security mechanism and safety latch - Horizontal door entrance (762 mm) (30") - Vertical door entrance (1980 mm) (78") - Edges equipped c/w flexible material - Drop moulding above each door opening - Grab rail along one side of entrance	No	- Door width only 546 mm (21.5") - No locking mechanism	- All other items as per spec. - See Chapter 5 for detailed evaluation
b Body, General Construction	- Prime commercial quality metal - All metal zinc coated or equivalent treatment process	Yes	- Fibreglas and vinyl used in several locations	- All other items as per spec.
c Communications	- Two-way 32 channel mobile radio c/w private dispatch and radio/telephone - AM/FM cassette c/w rear speaker	Yes		
d Driver Compartment	- Bucket seat, covered, fire retardant, washable, absorbent material - Seat belts	Yes		
e Driver's Partition	- Full width of seat - Covering to be fire retardant, washable and non-absorbent	Yes		
f Emergency Exits	- Two outward opening doors, min. 815 mm opening - English and French identification interior and exterior	No	- No identification on exterior of vehicle	- Doors as per spec.
g Floors	- 13 mm (1/2") plywood overlain by heavy-duty light covered lino	---	- None apparent	- Could not be checked

Table 4.1 cont'd.

2.0 BODY (cont.	ORIGINAL SPECIFICATION	VEHICLE SUPPLIED MEETS SPECS.	DEFICIENCY IF ANY	COMMENTS
h Glass	- Door and window glass tempered or double laminated safety glass - All glass tinted except windshield	Yes		- Note item 2.0 x
i Heating and Ventilation, Air Conditioning	- Heating, venting and air conditioning using recirculated and ambient air - One front heavy duty heater - 25,000 BTU/hr. capacity near driver's seat - Adjustable cut-off heater valve in cab - Heater lines to be properly supported and protected - Each hot water heater system c/w shut-off valves - One static type exhaust vent - Air conditioning for driver and passenger areas	No	- Hose to rear heater not clamped to chassis - Noisy (being repaired by dealer)	- No nameplate on rear heater - capacity unknown - Isolation valves for heater (brass or bronze) are corroding - All other items as per spec.
j Identification	- Accessibility symbol on rear left side of centre, right front and body sides - "Do Not Park Within 3 Metres of This Side"	No	- No handicapped symbol on sides of vehicle	- Other decal as as per spec. (minor item)
k Inside Height	- 1830 mm (72")	No	- Floor to ceiling = 1899 mm (74 3/4") - Floor to grab rail = 1778 mm (70")	- Overhead rail stanchions too long (can be easily modified)
l Insulation	- Floor insulation at least R30	---	- None apparent	- Could not be checked
m Lighting	- At exterior of lift door - auto operation - At passenger access, including rear door auto operation - Driver controlled interior lights c/w individual shutoffs - Passenger area dome lights	No		- Lighting at front door very poor - Rear exterior loading lights poorly directed - No driver control

Table 4.1 cont'd.

2.0 BODY (cont.	ORIGINAL SPECIFICATION	VEHICLE SUPPLIED MEETS SPECS.	DEFICIENCY IF ANY	COMMENTS
n Passenger Seating and Seats	- Seat to seat distance minimum 685 mm (27.0") - Rump width 508 mm (20") - Height to cushion seat between 400 and 480 mm (16 - 19") - Seat depth 380 - 430 m (15 - 17") - Seat back minimum 380 mm (15") - Clear passage between seats 760 mm (30") - Seat belts required	No	- Rump width only 450 mm (18") - Hold down system for seats poor, both from an operational and safety standpoint	- All other items as per spec.
o Seat Type and Arrangement	- Deluxe, high back, removable or foldaway armrests, good lumbar support, fire retardant, washable, non-absorbent - 5 seats	Yes		- Seat height from floor is excessive
p Projections and Padding	- All sharp projections padded including stanchions, grab bars/handles, guardrails, roll bars, above emergency exits, exposed stationary parts of lift	No	- Overhead rail stanchions, rear heater, and top of lift need padding	- Location of driver's interior rear view mirror does not allow sunvisor to fold away; projects horizontally into driver's area
q Rear View Mirrors	- Interior mirror - rounded edges/corners - provides good visibility - Exterior mirrors -one each side, no obstructions to visibility, adjustable mounts - Convex mirror also required	Yes		
r Roof	- Extended roof with structural members fastened to structural elements of body - To comply with CMVSS 220 (rollover protection)	---	- None apparent	- Could not be checked - Manufacturer's specification accepted
s Safety	- To CMVSS 302	---		- Not checked

Table 4.1 cont'd.

2.0 BODY (cont.	ORIGINAL SPECIFICATION	VEHICLE SUPPLIED MEETS SPECS.	DEFICIENCY IF ANY	COMMENTS
t Safety Equipment	- 1 - 5 kg (10 lb.) or 2 - 2.5 kg (5 lb.) fire extinguishers readily accessible (2 - A:10 B:C rating) c/w gauge - First aid kit mounted - in readily accessible location - Three advance road warning devices	No	- Only 1 - 2.5 kg (5 lb.) extinguisher (poor access to it)	- All other items as per spec.
u Steps	- 50 - 75 mm strip on leading edge - Dimensions: 1st step: 330 - 225 mm from ground Remaining steps: 200 mm max. in height Variation in height: 25 mm Depth: min. 215 mm Width: min. 400 mm All steps constant depth Nosing: max. 10 mm Nosing at floor flush c/w floor	Yes		- Poorly designed - See Ergonomist detailed evaluation in Chapter 5
v Sun Visor	- Adjustable, not less than 150 X 760 mm (6 X 30") - Adequately supported	No	- Visor 185 mm X 530 mm	- Support adequate
w Windows	- Both sides of passenger compartment capable of being opened	Yes		
x Windshield	- Tinted safety glass	No	- Not tinted	- Specification in conflict with Item 2(h)
y Wiring	- To SAE standards - Min. 14 gauge wire; circuits compatible with chassis wiring - Separate fuse or circuit breaker for each circuit and shall be easily accessible - Wiring to be insulated and protected and securely fastened	No	- Fuses by Girardin - not in holder - Some wiring not protected by loom	- All other items as per spec.

Table 4.1 cont'd.

3.0 BODY SAFETY	ORIGINAL SPECIFICATION	VEHICLE SUPPLIED MEETS SPECS.	DEFICIENCY IF ANY	COMMENTS
a Wheelchair Seating and Arrangement	- Forward facing - Accommodation for 3 wheelchairs and occupants on driver's side of vehicle	Yes		
b Wheelchair Securement	- Each wheelchair position to be securely fastened to limit movement and to CMVSS	Yes		- No instruction manuals for use
c Wheelchair Occupant Restraint	- Minimum lap belt required to CMVSS	Yes		- No instruction manuals for use
d Grab Bars/ Handles	- Grab bars/handles at each seat used by disabled persons - At each side of entrance used by disabled persons - Max. diameter including padding = 75 mm (3")	No		- None at seats; all other items as per spec
e Reading Light	- Directed to illuminate waist down	Yes		
f Lift	- To CSA CAN3-D409-M84 Section 8	Yes		- Checked by supplier

Table 4.1 cont'd.

4.0 EMERGENCY ITEMS	ORIGINAL SPECIFICATION	VEHICLE SUPPLIED MEETS SPECS.	DEFICIENCY IF ANY	COMMENTS
a Attendant Seating	- Swivel seat opposite head of stretcher portion - Seat to comply with passenger seat spec.	Yes		- Good seat for transfer from wheelchair
b Cost Fastener and Anchorage	- Ferno Washington Model 175-3or equivalent	Yes		- Ferno 175-3 supplied
c Floor Plan, Cot Placement	- Accommodation for 1 cot, head forward against wall on driver's side; cot to Ferno Model 26 or equivalent; horizontal grab bar at ceiling for escort	Yes		
d IV Holders	- Holders and strapping device to be provided - Holders over head and chest of cot occupant - Hook store flush to ceiling	Yes		
e Location of Medical Equipment and Supplies	- Trauma kit and Flynn Mark III resuscitator available to attendant from exterior door	No	- Not readily accessible to attendant	- All other items as per spec.
f Rear Door Entrance	- Handles designed to prevent accidental opening	Yes		
g Rear Floor Scuff Plate(s)	- 100 mm (4") wide; located on floor along rear door stretcher entrance	No	- Not supplied	
h Storage Areas	- Storage required for a M or 2 Q oxygen bottles forward of rear axle - Tanks mounted in crash-worthy resistant device to sustain 5G's - Oxygen bottle free of electrical devices - Resuscitator and trauma kit require storage	No	- Poor restraint system for oxygen bottle - Generally poor storage space in vehicle	- Smaller oxygen bottle ordered

5.0 ERGONOMICS EVALUATION

This chapter of the report describes the ergonomics field evaluation of the prototype multipurpose rural vehicle. The purpose of the evaluation was to obtain information that would provide a basis for drawing up guidelines for development of an ergonomically sound production model. Accordingly, it took the form of a systems analysis designed to cover all human/vehicle interactions involved in use of the vehicle.

In the following paragraphs, the design of the evaluation is explained, procedures are described, and general outcomes are presented along with comments and recommendations. Specific details and recommendations are contained in Appendix A which is organized around observations involving, respectively, the operator, the passengers, and the paramedics, and is an essential part of the ergonomics evaluation.

5.1 Evaluation Design

Preparation for the systems analysis entailed a systematic specification of all human/vehicle interactions as major operations of tasks performed by the operator, semi-ambulatory passengers, and the paramedics. (Wheelchair and stretcher-borne passengers are omitted from this list because they do not perform tasks in interacting with the vehicle.) These task operations were then broken down into elements that were small enough to relate meaningfully to vehicle design features so that, during observation, those features that might be violating human sensory, cognitive, motor, or psychological limitations could be pinpointed and studied. (Cognitive processes occur in the brain; they include perceptual processes such as detection, discrimination, and recognition, as well as decision-making and relevant response preparation.) A set of loading/unloading and ride factors was also defined for each type of passenger. A data collection protocol was then prepared for each type of user - namely, the operator, each of the three types of passenger, and the paramedics.

5.2 Procedures

5.2.1 Subjects

Subjects who were actual users of the vehicle were confined to the regular Handivan operator and three elderly passengers (two females and one male) picked up at their homes for booked trips to the Village hall. The operator was observed both in his regular role as driver of the vehicle and, along with a member of the film crew, as a stand-in for a paramedic. Stand-in roles for wheelchair, semi-ambulatory, and stretcher-borne passengers were undertaken by members of the evaluation team, one of whom uses a wheelchair for mobility.

5.2.2 Pretest of Protocols

At the site, a test inspection was made, with the regular operator, of all person/vehicle interactions and tasks, and task and other elements were added, discarded, or modified where necessary. Elements in the corrected lists were then numbered, thus enabling observations to be referenced against them more easily. Reference to Appendix 1 will apprise the reader of the content of the final lists of task elements and the nature of the passenger loading/unloading and ride factors addressed, as well as of the final format of the data collection protocols.

5.2.3 Observation and Data Collection

In simulated task scenarios, the operator was observed in the following categories:

- loading and unloading wheelchair and semi-ambulatory passengers;
- fastening and releasing the wheelchair securement and occupant restraint systems;
- preparing for the loading and unloading of a stretcher passenger;
- carrying out general administrative tasks;
- preparing for vehicle operation; and
- maneuvering the vehicle.

Simulations involving the two stand-in paramedics consisted of:

- preparing the stretcher to load a patient;
- loading and unloading the stretcher;
- fastening and releasing the stretcher securement;
- accessing and using the cotside seat;
- accessing, administering, and replacing the medical equipment; and
- using the two-way radio.

The tasks for these categories were performed element by element, slowed down and repeated several times so that the relationship between the vehicle design features involved and the responses of the subjects could be closely examined. The paramedics were also filmed loading and transferring a stand-in stretcher case to a nearby hospital, during which time observation from a holistic perspective was undertaken.

Wheelchair passengers, observed while boarding, deboarding, and riding over a variety of road surfaces, reported on feelings of comfort and security, as well as on sensation of wheelchair movement both while riding and on the lift. The stand-in stretcher case was observed and asked to report on the same types of reactions, but as related to the stretcher experience. Semi-ambulatory passengers reported similarly after being observed with respect to biomechanical difficulties encountered on boarding and deboarding the vehicle, walking to and from the seat, stowing and retrieving walking aids, and securing and releasing the seat belt. All passenger subjects were queried on factors such as comfort and sense of security, and on internal environmental factors such as visibility, aesthetics, noise, temperature, and air quality.

Numerous queries were made during observations. Pencil and paper recordings were made of any difficulties observed or reported. If no difficulty was encountered, the activity or factor was rated "0"; otherwise it was rated "1" or "2" to indicate the nature of the problem as, respectively, minor or major. Each human problem was defined and related to either a specific design feature and/or a procedure underlying it; remedial suggestions were added where possible. At the end of each session, all subjects were asked to comment on the general adequacy of the vehicle design, the procedures associated with it, and the utility of the concept.

5.3 Results

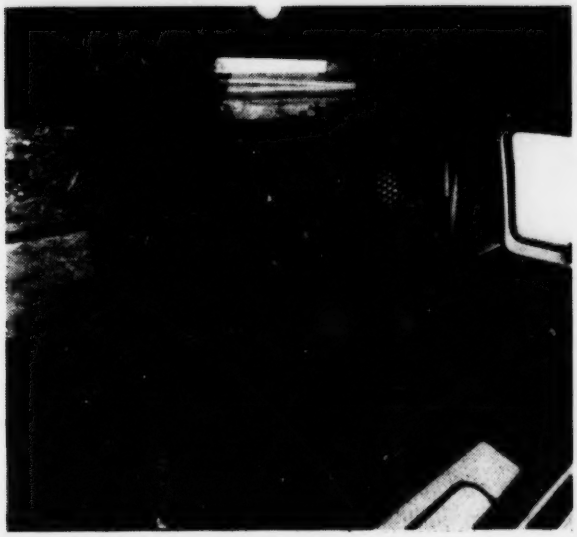
The synthesized information obtained from the evaluation is arranged in tabular form in Sections 1, 2, and 3 of Appendix A covering findings regarding operator, passenger, and paramedic interactions with the vehicle, respectively. As these tables contain an immense amount of detail, they are not easily summarized. Accordingly, only some general observations and a few major outcomes are presented here under select headings. Figure 5.1 illustrates many of the features evaluated.

5.3.1 Safety

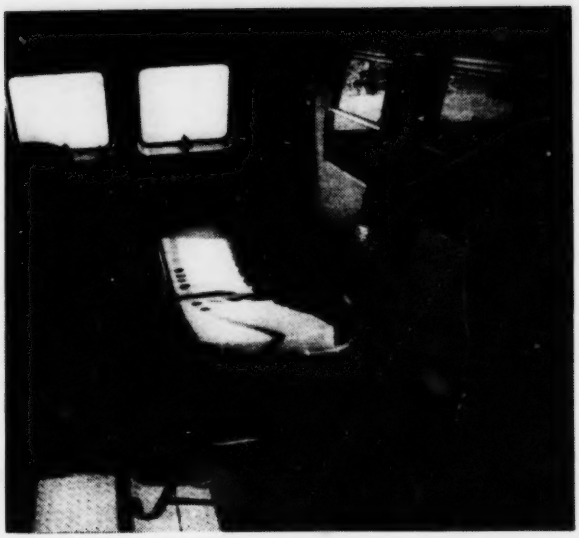
Numerous safety hazards associated with use of the vehicle are discussed below in terms of the type of person(s) they affect.

(a) Operator: One of the most critical safety hazards is the fast and sudden snap of the side guard moving into place when the Collins lift is lowered. Given the limitations on human information-processing and attentional capacity, it should not be assumed that the operator's prior knowledge of the action renders him immune to error in positioning himself, nor that the lettered warning appearing on the apparatus will be noted by others who may be in the critical region.

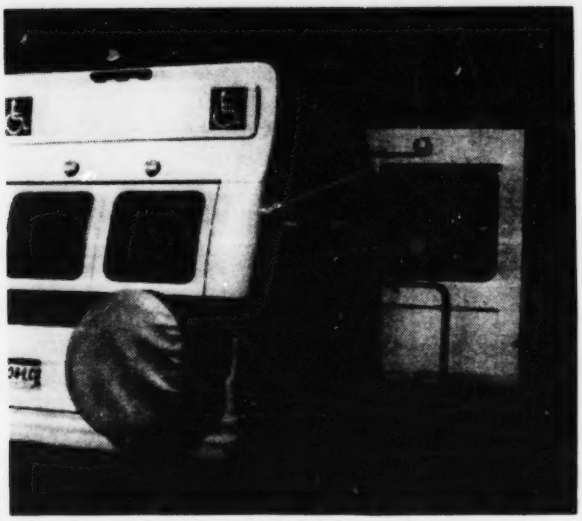
(b) Semi-Ambulatory Passengers: The Handi-Van vehicle was designed for passenger entry from the sidewalk. However, Minitonas passengers on foot or with walking aids usually enter the vehicle from the pavement and, hence, face an initial step that is far too high. To overcome the problem, the operator has had to make a small wooden stool which, having no support system, may leave the passenger unstabilized and, being unanchored to the vehicle, may tip or slip on uneven, wet, or icy ground. Hazard on entry is increased by the facts that the rises of the two remaining steps differ (thus putting the passenger off pace), the runs are too shallow for a good footing, the overhang risks toe-catching, the top step is uneven, and lighting is insufficient. The narrowness of the door space compounds entry problems. Grab rails meant to assist ambulatory passengers are too small in diameter for a good grip, inappropriately placed, and too sharply angled; therefore passengers often use the door-opening lever instead. The vertical pole at the top step is unsafe for support as its tubular covering rotates around the pole. There is no support system between the front door and the seating, except the overhead



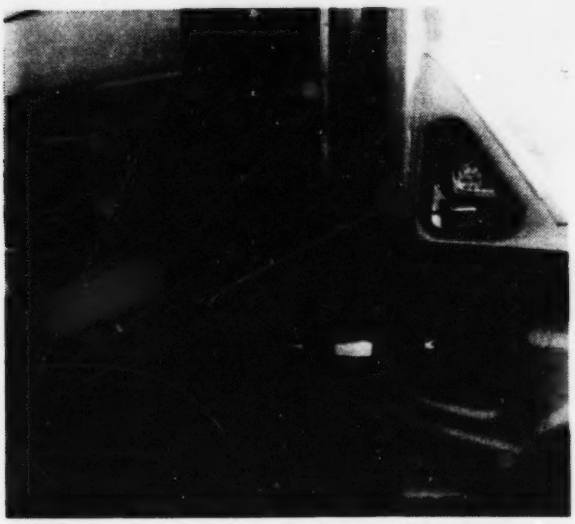
a) Interior (right rear) view of folded lift and typical seating.



b) Interior (left rear) view of stretcher and dangling restraint straps.



c) View of extended lift and spare tire that interferes with right stretcher door.



d) View of narrow entrance and steps.

Figure 5.1

Illustration of Handivan Design Features

rail which is not useful to the semi-ambulatory and elderly (and, in any case, presents a hazard to an operator only slightly taller than the current one). In sum, these features present a decided risk to the elderly, among whom falls are reportedly highly prevalent.

Despite lap belts, seated passengers may be subject to injury if the seats are not mounted securely. Crash testing of these seats with anthropometric dummies, if not already carried out, is advised. Additionally, training might be given to ensure that the seats are mounted correctly. Observed seated passengers did not use the provided seat belts; asking such passengers to do so routinely would be a good safety precaution.

(c) Wheelchair Passengers: Other safety concerns relate specifically to wheelchair passengers. For example, the safety stop on the lift gives protection only so long as the wheelchair passenger is pulled or pushed on facing away from the van. As either of these actions strains human biomechanics, there could be a temptation to wheel the chair on from behind, thus leaving the safety stop ineffective against the large rear wheels. There is no protection on the right-hand side of the lift.

Inside the vehicle, passengers in wheelchairs may also be at risk of injury in the event of a vehicle accident. It is relevant that, during the evaluation, the wheelchair securement system appeared to allow movement of the wheelchair during turns. As the Q'STRAINT system has been barrier crash tested with anthropometric dummies, the experienced effect may have been simply a perceptual phenomenon; alternatively it may have been that the tightening clamps on the rear belts had not been used properly. Additionally, at time of the evaluation, the passenger restraint system had not been used because instructions were not available, and neither the operator nor anyone on the evaluation team could perceive how it worked. The parts of Q'STRAINT are, of course, intended to operate as a system; and, while the necessary instructions have since been provided, observations during this evaluation suggest that having instructions readily available and ensuring that any new operator is properly instructed in how to use the Q'STRAINT system as a whole are important for obtaining its demonstrated safety protection. Finally, it was noted that no headrest is available, a fixture known to be necessary for protection of wheelchair passengers against neck whiplash.

(d) Stretcher-Borne Passengers: Passengers entering the vehicle on a stretcher may sustain physical insult due to bumps and jarrings that occur for a number of reasons. First, because the spare tire is secured to the right rear door, clearance in loading the stretcher has been considerably reduced. This situation is compounded by the fact that the stop for the left rear door is buckling. Finally, the step at the rear doors is obstructing the smooth loading of the stretcher. This step could perhaps be made retractable. In any case the entire door system should be such as to take account in the widest sense of any human error that could affect the patient adversely.

(e) All Vehicle Users: All individuals riding in the vehicle are subject to injury, first, because there is no place to store carried-on equipment such as walking aids, or essential equipment such as the jack and tire iron which, consequently, are lying on the floor at the rear of the vehicle; all of these could become flying missiles in the event of an impact to the vehicle. Additionally, the oxygen tank does not seem to be adequately secured. As, in any case, there is no regulator for this tank, it may well be that it could be replaced by a back-up to the existing portable oxygen kit. Apart from the foregoing, various rough, sharp, and/or protruding parts of the interior present hazards. For example, a sharp bolt protrudes from the front door lever bar which, itself, is constructed of rough metal. In addition, the auxiliary heater has both sharp edges and a hot surface to present to the ankles of a passenger who may not have seen it in its virtually hidden location beside the second right-hand passenger seat.

5.3.2 Ergonomics of the Operator's Task

(a) Passenger-Handling Tasks: Both mental and physical loading are seriously associated with the operator's task. Mental load relates largely to the handling of wheelchair passengers which, as a glance at Table A-1a in Appendix A will confirm, entails a lengthy series of routinized task elements. The regular operator, who is well practised, has reached a stage at which these elements can be run off virtually without conscious effort. However, it is well known in the ergonomics literature that disruption of the 'program' during performance of an autonomously run task can result in error - in this case, errors such as failure to put on the wheelchair brakes, or to stand clear of the guard rail, have implications for safety. A person new to the task would be even more subject to errors of these kinds because of the load on memory during learning. Accordingly, new technology in these situations would do well to aim at greatly simplifying the operator's task and/or providing feedback as certain elements are performed.

Physical load is due to numerous aspects of the passenger-handling task that force the operator into disadvantageous postures, placing undue stress on the lumbar spine and other parts of the musculo-skeletal system. For example, to fasten and release the four-point wheelchair securement system, the operator must reach down to the floor four times, an action which is at the very least energy-consuming and, at the front inside point, seriously involves forward flexion and rotation of the thoracic and lumbar spine, along with flexion and rotation of hips and knees. Removing the seats to make room for the stretcher or wheelchair also places static physical load on the lumbar spine and other parts of the body because the bolts do not readily slide into their keyhold positions on the floor and, therefore, the operator must struggle with the large bulk of the chair to loosen it. Lifting the chair and carrying it out of the vehicle is biomechanically awkward, thus augmenting and prolonging stress from the previous task.

Another task that strains human biomechanics is that of loading the wheelchair so that it faces outward from the lift. Here the operator must either lean over to reach the armrests to push the chair onto the lift or, with very little mechanical advantage, pull it on from the rear by cramming into the very narrow space between the lift and the side of the van.

The cumulative effects of repetitive stress to the musculoskeletal system of the kinds just described are known to result in debilitating damage to muscles, tendons, ligaments and, eventually, joints. It must be recognized, of course, that the retrofitting of existing vehicles places enormous constraints on what the design engineer can do, and that trade-offs are accordingly necessary. However, a rule of thumb would be that technology should do whatever it can in the future to eliminate stress to the operator who, then, should be trained to handle the remaining physically loading tasks in a way that minimizes the deleterious effects to the body.

(b) Work-Station Tasks: In addition to the foregoing, certain inconveniences and strains are associated with tasks carried out by the operator in his work station as controller of the vehicle. First, the step into the cab is so high that he must pull on the steering wheel to get in. Although the seat appears to be comfortable, a movable armrest would be a welcome addition, especially on long trips. There is no accessible place to put record books and collected fares; a pocket on the back of the seat is suggested as a tentative solution. No problem has been experienced reading displays, except that on the digital clock which is unreadable in sunlight. The microphone for the two-way radio is inappropriately placed, forcing the operator to leave it dangling after use while driving rather than look up to replace it. The distance the lever must be pushed to open the right front door would be too great for someone with an arm only slightly shorter than that of the regular operator; the action itself requires a considerable amount of effort. While the mirror affords an excellent view of the passengers behind, it interferes with the sun visor which, as a consequence, hits the operator on the head. Visibility, aided by an excellent system of external mirrors, is very good; however, the door post creates a troublesome blind spot. Although the operator reported no difficulty with vehicle controls, it is noted that the brake pedal is higher than that for the throttle, a geometry that can dangerously increase movement time from throttle to brake, especially since it risks catching the shoe on the brake pedal during this movement. For maximal safety, the brake pedal should be lower than, or at least at the same height as, the throttle pedal. Vehicle maneuverability appears to be satisfactory.

(c) Maintenance Tasks: The operator is also responsible for the cleaning and maintenance of the vehicle. Unfortunately, there was not enough time to explore the ergonomics of these tasks. Suffice it to say that, in a design of the ideal model, they would need to be carefully considered.

5.3.3 Passenger Factors

(a) Comfort: Discomfort and, in some cases, pain and spinal insult may be experienced by some passengers, especially on trips of more than ten-minute duration. Although the stretcher stand-in (well cushioned as she was in her low-to-floor position) did not experience jarring as the vehicle passed over frost heaves in the road, the vehicle's suspension system is such that other types of passengers did. More seriously, the wheelchair passenger (who, even with a cushion, lacked the shock absorbent buffer of the upholstered seats) was continually jolted vertically, even on smooth roads. These painful shocks to the spinal column could seriously exacerbate existing back problems which are prevalent among those who are in wheelchairs because of neuromuscular diseases.

The seat and back of chairs for semi-ambulatory and elderly passengers offer good support. However, the height, while facilitating easy ingress and egress, will leave many passengers with their feet dangling or sitting in adverse positions. This uncomfortable and medically undesirable situation could be corrected by providing footrests.

(b) Sense of Security: A sense of insecurity in semi-ambulatory passengers attempting to board and deboard the vehicle and ambulate within it is undoubtedly created by the step configuration and absence of inside support rails, already mentioned with respect to safety. (On the other hand, these passengers tend to feel safe in their seats with only lap belts on, though they may well not be.) Depth perception, lack of a right-hand-side guard rail, and start-up jerk will tend to induce a sense of insecurity in some wheelchair passengers while using the Collins lift.

(c) Visibility: Inside the vehicle, windows are too low for wheelchair passengers who, accordingly, must crook their necks to obtain a good view outside. In any case, windows are without shades and, therefore, contribute to visual dazzle by reflecting distorted images; glare from the large concave mirror system on the front right of the vehicle adds to this effect.

(d) Aesthetics: Although the vehicle exterior is aesthetically pleasing, the interior is rather lacking in this respect. For example, the floor has a cold metallic appearance, the walls are a clinical white and, as mentioned, there are no window shades. No overhead compartments conceal equipment, which is instead strapped to the floor with velcro or, as is true for the Q-STRAINT belts and wheelchair securement straps, dangling from hooks on the wall.

(e) Noise, Temperature, Air Quality: Numerous squeaks and rattles, including the flapping of the wheelchair securement and passenger restraint straps against the wall, can be heard. The heating and air conditioning systems work very well and are effective right to the rear of the vehicle. However, some passengers may be bothered by drafts occurring during loading of wheelchairs, at which time at least two doors are open. An odour of gas was frequently detectable in the vehicle.

5.3.4 Social and Organizational Factors

Several factors, including perceptions and attitudes, may contribute to underutilization of the vehicle. First, not many individuals in Minitonas are disabled, and those that are tend to be driven about by relatives. As well, it is possible that seniors see a stigma attached to anything that suggestes disablement. Nevertheless, clients participating in the evaluation consistently expressed delight with the vehicle concept, mentioning that its usefulness could be increased through driving seniors and others to recreational events such as picnics, church festivals and town celebrations.

At the time of the ergonomics evaluation, the emergency service had yet to be used. In order to prepare for this type of use, the operator and one other person must be trained and allowed to practice together in handling the stretcher, administering medical aid if necessary, and performing all other relevant operations. In addition, a system whereby the two-way radio is always operational will need to be established.

5.4 Discussion

In the time available, it was not possible to carry out an exhaustive in-depth ergonomics analysis. Nevertheless, it is clear that many human factors problems inhere in the vehicle. Problems associated with the operator's tasks are notably large in number, due perhaps to an understandable tendency for first efforts in design of such vehicles to focus on simply getting the passengers in and out. It is, in fact, possible that this evaluation breaks ground in covering operator/vehicle interactions in a comprehensive fashion.

Whatever the history, the outcomes of this evaluation do strongly suggest that the operator is at very high risk of incurring serious damage to the musculoskeletal system. Apropos of this matter, the altruistic tendency of people to endure stress cheerfully for the sake of those physically less fortunate is sometimes dangerous because the cumulative effects of repeated gestures of this kind can be in the form of chronic and debilitating pain in muscles, tendons, ligaments and, eventually, joints. So as to reduce the probability of these outcomes as much as possible, it is recommended that future design efforts give consideration to the factors cited in this report wherever possible, and to supplement modified design with training of the operator in postures that are minimally stressful for all tasks.

In addition to physical load to the operator, a plethora of small elements comprising his/her task create very high mental load. Under conditions of this sort, the probability of 'forgetting' - due to distraction of attention, fatigue, or other factors - is greatly increased so that task elements that have implications for safety may be omitted. It is recommended that modification, and future development, work toward decreasing as many of the operator task elements as possible and providing feedback regarding those that are critical to safety.

Several human factors problems mentioned in this report are related to safety. Some of these, such as the protrusion of sharp parts into human operating space and the storing of loose parts in the vehicle, lend themselves to easy remedy. In other cases - those in which a system or part has been made to some standard or represents the state of the art for the industry - the solution may not be straightforward. Here, decision-makers will want to consider whether any or all of a number of approaches - new instruction, training, a change in procedure, or a technical modification - will suffice, and/or whether the entire design must be reconceptualized.

Although exceedingly important, passenger factors - such as sense of security, visibility, aesthetics, and environmental features - do not loom as serious concerns in the overall ergonomics picture of the vehicle in question, as most of the discovered difficulties can be removed through fairly simple measures. The discomfort experienced by wheelchair passengers because of the suspension system may be more problematic; yet it calls for some early solution, since damage to spinal discs is a real possibility in these cases.

Any decisions regarding how the human factors problems discovered during the evaluation are solved are best made on the basis of the full and detailed account in Appendix A. However the developer is cautioned against having any of the suggested modifications carried out in an elementalist fashion on the existing vehicle. The fact is that, because they are rather numerous, many interact with one another, some may even contradict each other, and all are offered only as starting points to be weighed against design constraints brought about by structural and other fixed properties of vehicles.

Apart from providing information that will be useful for immediate decision-making, the ergonomics evaluation is meant to serve as preliminary data to guide the development of specifications for a new vehicle model. It is true that the human/machine system, of which the vehicle in question is a part, is not only novel in its multipurpose concept, but also very complex ergonomically, involving as it does an operator/passenger attendant, at least three different types of passengers, and paramedics. When factors such as these apply, getting a prototype (however rudimentary) into the field is often regarded as a good way of gathering the detail necessary to allow development to proceed toward an ergonomically sound version. The ergonomics evaluation reported here is of the kind that fulfills such a purpose.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Applicability to the Site Selected

From the point of view of the residents of the Village and Rural Municipality of Minitonas, the multipurpose vehicle is more than adequate for their current public transport service needs. After 20 months of operation, the vehicle has been well accepted by the residents. Credit for this must be given to the two Handivan operators who have been instrumental in generating confidence in the vehicle and the service offered.

The seating capacity is appropriate for present demand levels, however it may not be sufficient in the future. Since a backup vehicle would be desirable in the event of a breakdown, a second more conventional (and less costly) vehicle could be acquired. An alternative would be to pool the Swan River and Minitonas handivans so as to provide the appropriate vehicle for specific trip needs.

Another possibility would be to provide Minitonas with a larger-capacity dual-purpose vehicle so as to be able to test the multipurpose vehicle in more remote communities that do not have an emergency service. If this option is contemplated, the desirable modification described in Section 6.3 should be made before placing the multipurpose vehicle back in service.

6.2 Applicability to Other Rural Communities

The need for a dual-purpose rural vehicle, capable of serving the elderly and the ambulatory disabled and equipped with a lift for the physically disabled, is well established. The Minitonas experience indicates that multipurpose vehicles have potential application in rural municipalities which do not have emergency service within 20 to 30 minutes travel time. The need for a multipurpose vehicle for a specific size or type of community is still somewhat speculative, and must be discussed from provincial and federal perspectives.

6.2.1 Provincial Perspectives

Most provincial administrations do not seek out communities in which to implement transport services. They wait for the communities to ask for assistance. Such is the case in Manitoba.

The concept of a multipurpose rural vehicle is so new that local governments are unlikely to be aware of the technology. If provincial health and transportation departments conclude that the multipurpose vehicle has merit, then local governments need to be advised of the options available to them. This could be done in the following ways:

- circulation of this report;
- circulation of the Minitonas Handivan video produced during the course of this project;

- provision of a demonstration vehicle that could be loaned to local communities for short periods of time for their evaluation.

6.2.2 Federal Perspectives

From the Federal perspective, the concept of a multipurpose rural vehicle appears to be valid, but considerable additional development work is required. The vehicle supplied to the Province of Manitoba and tested in Minitonas no doubt reflects several compromises apparently based on what could be obtained for the funds available at the time. The design of the stretcher configuration has been very well done, however the vehicle does not represent the highest state-of-the-art with respect to small bus design.

In addition, the ergonomics evaluation suggests that there is considerable room for general improvement in vehicles intended to serve the disabled. Federal activities to overcome this and other problems noted above could include:

- the production of a second generation multipurpose vehicle for testing;
- the development of minimum standards of accessibility for small vehicles serving the disabled.

6.3 Recommended Modifications to Prototype Application

If the existing multipurpose vehicle is to remain in active service, there are a number of desirable modifications that should be considered. These modifications have been discussed with the representatives of the Village and the R.M. In the short term the following recommended modifications are expected to be made:

- Arrange for a local body shop to add interior storage compartments for tools and to file down or cover all of the sharp edges noted in the mechanical and ergonomics evaluation.
- Replace the portable step with a commercial step with a spread footing.
- Install a battery isolator.
- Replace corroding heater valves.
- Add an operator's interior light control switch.

In the longer term, if the vehicle should require major body work or chassis repairs, the following are recommended:

- Replace the existing suspension components with a "softer suspension" and add an air support bellows.
- Install a second fuel tank with a dash-mounted selection switch.

6.4 Recommended Modifications to Design

If the existing multipurpose vehicle is considered to be a first generation prototype, then the following modifications should be made to the second generation of vehicles.

1. Redesign the front entrance to provide wider doors, to eliminate uneven step heights, and to provide for passenger support. If possible, install an auxiliary step for use when the vehicle is not at curb level (note recreational vehicle applications).

2. Redesign the interior of the bus to eliminate safety hazards, including sharp projections. Offset the passenger overhead rails to improve headroom and/or install soft passenger support straps.

3. Redesign the floor mounting system for removable seating. Use aircraft-type track so that seats can be removed without risk of injury to the operator.

4. Redesign the suspension system to provide for a variation in support depending upon load requirements.

5. Specify the minimum window requirements including: size of glass, tinting, and interior curtains.

6. Offer alternative seating layouts with fewer wheelchair positions.

There are at present about 350 special transport services for the disabled in Canada operating some 1,300 to 1,400 vehicles.(7) These operators have a wealth of practical experience to contribute to the further development of national standards (such as CSA Standard CAN3.D409-M84) for vehicles serving the disabled. The operators should be consulted when specifications are being developed for multipurpose vehicles.

Major automobile manufacturers have recently begun offering vehicles with "ergonomically designed" interiors. Manufacturers and re-manufacturers of special vehicles for the disabled would benefit greatly from a similar approach. Consultation with ergonomists who have developed strategies for studying the relevant person/system interactions and who can assist designers in selecting options in a systematic way could result in much better vehicle designs.

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APPENDIX A

TABULATION OF RESULTS

OF

ERGONOMICS EVALUATION

From an original manuscript
by
HERON ERGONOMICS

Sections:

A-1 Results: Operator
A-2 Results: Passengers
A-3 Results: Paramedics

APPENDIX A-1 RESULTS: OPERATOR

Table A-1a

Key to Operator Task Elements

A RECONFIGURE VEHICLE
- 01 slide chair bolts to keyhole position
- 02 lift chair
- 03 remove from vehicle

B LOAD WHEELCHAIR PASSENGER
- 01 exit vehicle
- 02 open lift door
- 03 secure lift door
- 04 unhook lift control module/pull switch down to unfold/press "lower" to lower lift/hook module onto lift-door eye
- 05 load wheelchair onto lift
- 06 put brakes on wheelchair
- 07 unhook lift control module/push "raise" to raise lift/hook module onto inside eye
- 08 enter vehicle
- 09 remove wheelchair brakes
- 10 maneuver wheelchair into place
- 11 remove wheelchair securement straps from wall hook
- 12 secure wheelchair
- 13 remove passenger restraint system from wall hook
- 14 apply passenger restraint system
- 15 exit vehicle
- 16 unhook lift control module/push switch up to fold/hook module on inside eye
- 17 release lift door securement
- 18 close lift door
- 19 enter vehicle

C UNLOAD WHEELCHAIR PASSENGER
- 01 exit vehicle
- 02 open lift door
- 03 secure lift door
- 04 unhook lift control module/pull switch down to unfold/hook module onto lift-door eye
- 05 enter vehicle
- 06 release wheelchair securement straps
- 07 replace securement straps on wall hook
- 08 release passenger restraint system
- 09 replace restraint system on wall hook
- 10 maneuver wheelchair onto lift
- 11 secure wheelchair brakes
- 12 exit vehicle
- 13 unhook lift control module/press "lower" to lower lift/hook module onto lift-door eye
- 14 release wheelchair brakes
- 15 push passenger to destination
- 16 unhook lift control module/press "raise" to raise lift/push switch up to fold/hook module onto inside eye
- 17 release door securement
- 18 close lift door
- 19 enter vehicle

D LOAD SEMI-AMBULATORY PASSENGER
- 01 push lever forward to open step door
- 02 assist passenger ingress if necessary
- 03 stow walking aids, if any
- 04 pull lever to close step door

Table A-1a (continued)

E UNLOAD SEMI-AMBULATORY PASSENGER
- 01 push lever to open step door
- 02 assist passenger egress if necessary
- 03 pull lever to close door

F PREPARE TO LOAD STRETCHER PASSENGER
- 01 exit vehicle
- 02 open rear doors
- 03 secure doors
- 04 install stretcher clamps
- 05 assist paramedics if necessary
- 06 release door securements
- 07 close rear doors
- 08 enter vehicle

G PREPARE TO UNLOAD STRETCHER PASSENGER
- 01 exit vehicle
- 02 open rear doors
- 03 secure doors
- 04 assist paramedics if necessary
- 05 remove stretcher clamps
- 06 release door securements
- 07 close rear doors
- 08 enter vehicle

H OPERATE VEHICLE
- 01 open cab door
- 02 access seat
- 03 close cab door
- 04 read/interpret displays
- 05 manipulate controls
  - 05.1 turn key to start engine
  - 05.2 shift gears (automatic)
  - 05.3 depress throttle pedal
  - 05.4 depress brake pedal
  - 05.5 depress emergency brake foot pedal
  - 05.6 signal left/right/emergency flasher
  - 05.7 turn steering wheel
  - 05.8 push/pull headlight button
  - 05.9 depress foot-operated dimmer switch
- 06 scan environment - ahead/rear/peripherally
- 07 maneuver vehicle
  - 07.1 drive forward/backward
  - 07.2 turn left forward/backward//right forward/backward
  - 07.3 accelerate/decelerate
  - 07.4 park angle/parallel
- 08 operate radio

I ADMINISTER FIRST AID AND/OR EMERGENCY PROCEDURES
- 01 access/replace first aid kit and other medical materials
- 02 administer first aid
- 03 access/replace fire extinguisher, night flares, etc.
- 04 operate fire extinguisher, night flares, etc.

J ADMINISTRATE OPERATOR FUNCTION
- 01 record calls, fares collected, maintenance expeditures
- 02 prepare reports of calls, fares, and maintenance expenditures

K CLEAN AND MAINTAIN MECHANICAL INTEGRITY OF VEHICLE
(no observations of relevant tasks)

Table A-1b

Operator Task A (Reconfigure Vehicle)

1 ELEMENT A 01

RATING

- 2

PROBLEMS

- chair bolts do not slide readily into keyhole position of floor mountings
- static load to lumbar spine incurred by push/pull action with trunk flexed to work bolts into position
- frustration adds mental load

REMEDIAL SUGGESTIONS

- improve sliding property; or redesign

2 ELEMENTS A 02/03

RATING

- 2

PROBLEMS

- flexed upper limbs must be abducted at shoulder joints to accommodate width of chair, and shape and bulk of chair prevent symmetrical use of arms
- greatly augments and prolongs musculoskeletal stress due to previous task element

REMEDIAL SUGGESTIONS

- supply lifting/moving aid

Table A-1c

Operator Tasks: B (Load Wheelchair Passenger)
C (Unload Wheelchair Passenger)

1 ELEMENTS B 01/02/03/08/15/17/18/19
C 01/02/03/05/17/18/19

RATING

- 2

PROBLEMS

- lift door cannot be closed without pushing on lift with hand
- no marked design deficiency observed for other separate elements, but plethora of small task elements in wheelchair loading task creates load on memory and risks unsafe handling
- two vehicle exits and re-entries required as well as opening and closing of both front and lift door, adding to time and energy consumption for task

REMEDIAL SUGGESTIONS

- adjust lift in folded position so door can be closed easily
- redesign, if possible, to simplify operator's task

2 ELEMENTS B 04/07/16
C 04/13/16

RATING

- 2

PROBLEMS
- side guard on lift moves up with fast sudden snap; printed warning message insufficient; operator's memory too loaded to ensure he stands clear
- lowering lift onto high curb risks damage; sign to keep clear not visible when angle parked
- too many task elements required in operation of lift make for inefficiency in design of operator's task; high mental load involved risks unsafe handling
- reaching inside to hook or unhook control module at home eye is awkward
- control module display is functional, but design requiring module to be held in one hand and operated with the other is inefficient

REMEDIAL SUGGESTIONS
- movement of side guard must be slowed down; warning signals should be added; or redesign this part of system
- sensor needed to stop lift on reaching curb; make residents aware of angle parking problem; try different type of signage
- more sophisticated lift control system (one that reduces number of task elements) recommended
- check operation of fold/unfold switch; for maximum efficiency, module should be operated with digits of hand holding it

3 ELEMENTS B 05
C 15

RATING
- 2

PROBLEMS
- wheelchair must face away from vehicle to be stopped by front and safety guard from rolling off lift platform; thus, adverse postures must be assumed by operator to push wheelchair onto or to pull it off lift, or to squeeze into narrow space between back of lift and vehicle to pull wheelchair on or push it off

REMEDIAL SUGGESTIONS
- redesign if possible so wheelchair can be pushed on facing vehicle, or sideways; many passengers could then propel wheelchair into van at floor level or off lift at sidewalk or ground level; (participating in operations may tend to enhance passenger's feeling of independence)
- a design allowing operator to ascend/descend with passenger would also eliminate problems

4 ELEMENTS B 06/09
C 11/14

RATING
- 1

PROBLEMS
- operator must lean over wheelchair to put on and release wheelchair brakes, adding stress to lumbar spine

REMEDIAL SUGGESTIONS
- encourage operator to request client to perform operations whenever approprate

5 ELEMENTS B 10
C 10

RATING
- 2

PROBLEMS
- configuration forces operator into awkward maneuver to push wheelchair into place, rotating chair and pulling toward back of van, then pushing forward, and lifting to adjust leftward to be flush with floor mounts; maneuvering out from the floor-mount position is also awkward

REMEDIAL SUGGESTIONS
- moving floor mounts slightly toward centre of vehicle might facilitate maneuvers

6 ELEMENTS B 11/12/13/14
C 06/07/08/09

RATING
- 2

PROBLEMS
- securement and restraint straps not easily reached by operator.
- attachment of securement straps forces operator into extremely adverse postures, particularly at inside left point where the operation involves forward flexion and rotation of the thoracic and lumbar spine, along with flexion and rotation of hips and knees; insufficient space to secure rear straps (operator opens rear door to do so); 4-point system demands repetition of physically loading task elements; cumulative effects of repetition of these tasks can seriously affect the integrity of operator's musculoskeletal system
- at the time of the evaluation, instructions were missing

REMEDIAL SUGGESTIONS
- for short term, move wheelchair floor mounts toward centre of vehicle, if possible, to allow operator more room to attach front inside securement strap; move toward centre, if possible, to allow room to attach rear straps; for long term, redesign wheelchair securement to eliminate repetitive physically-loading operator task elements, if possible
- for short term, provide instructions and training; for long term, include headrest for full protection

---

Table A-1d

Operator Tasks: D (Load Semi-Ambulatory Passenger);
E (Unload Semi-Ambulatory Passenger)

---

1 ELEMENTS D 01/04
E 01/03

RATING
- 1

PROBLEMS
- reach distance to push and retrieve door lever too long
- considerable effort required to push and pull lever
- no operator switch for interior lighting (controlled through door switch)

REMEDIAL SUGGESTIONS
- redesign, if possible, to reduce movement distance of lever and force needed to operate it
- provide interior light switch for operator

2 ELEMENTS D 02
E 02

RATING
- 2

PROBLEMS
- operator assistance made necessary by difficult step features and absence of appropriate support systems at entrance and between door and seating (see Appendix A-2 for further details)
- door is too narrow for operator to assist passengers on steps

REMEDIAL SUGGESTIONS
- see Appendix A-2 for details on steps and passenger support system
- semi-ambulatory having difficulty on steps could use lift

3 ELEMENT D 03

RATING
- 2

PROBLEMS
- no place to stow walking aids; if left on floor, these could become flying missiles in event of accident

REMEDIAL SUGGESTIONS
- provide overhead compartments or receptacle for walking aids, along with securement

---

Table A-1e

Operator Tasks: F (Prepare To Load Stretcher Passenger);
G (Prepare To Unload Stretcher Passenger)

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1 ELEMENTS F 01/08
G 01/08

RATING
- 2

PROBLEMS
- at front passenger door, lever system involved; at cab door, high step forces operator to pull on steering wheel to get in; stress to quadriceps involved

REMEDIAL SUGGESTIONS
- redesign, if possible, to reduce movement distance of lever and force needed to operate it as previously noted (see Table A-1d, Item 1 on page 48 for details on lever system)
- lower step at cab door; add support, if necessary

2 ELEMENTS F 02/07
G 02/07

RATING
- 0

3 ELEMENTS F 03/06
G 03/06

RATING
- 2

PROBLEMS
- tendency to close rear doors while securement still in place caused metal securement to buckle; door not perceived as being secured

REMEDIAL SUGGESTIONS
- high load on operator's memory means problem best solved by providing stronger securement; device with larger dimensions will facilitate perception of door as secured; some sort of warning signal might also help

4 ELEMENTS F 04
G 05
RATING
- 0
COMMENTS
- no problems observed in operating stretcher clamps

5 ELEMENTS F 05
G 04
RATING
- 2
PROBLEMS
- unclear whether operator to act as a paramedic, merely to assist with medical equipment, etc., or to stay clear and allow paramedic to act on own
REMEDIAL SUGGESTIONS
- define operator and paramedic roles clearly, and provide relevant training and practice

Table A-1f

Operator Task H (Operate Vehicle)

1 ELEMENTS H 01/02/03
RATING
- 2
PROBLEMS
- step into cab too high; operator grabs steering wheel for assistance; strain to quadriceps involved
REMEDIAL SUGGESTIONS
- lower step at cab door; provide support, if necessary

2 ELEMENT H 04
RATING
- 1
PROBLEMS
- face of digital clock cannot be seen in sunlight
- no problems reported with other displays
REMEDIAL SUGGESTIONS
- provide glare-proof face cover; increase figure/ground contrast

3 ELEMENTS H 05.1/.2/.3/.4/.5/.6/.7/.8/.9
RATING
- 2
PROBLEMS
- brake pedal is higher than throttle pedal, thus increasing movement time from accelerator to brake, especially if shoe catches on brake pedal
- no problems reported with respect to other operations
REMEDIAL SUGGESTIONS
- adjust height of accelerator pedal relative to brake pedal

4 ELEMENT H 06
RATING
- 1
PROBLEMS
- mirror system good, but blind spot at right front door post troublesome to operator
REMEDIAL SUGGESTIONS
- blind spot should be eliminated, if possible, in any newly-designed vehicle

5 ELEMENTS H 07.1/.2/.3/.4
RATING
- 0
COMMENT
- (maneuverability was tested by several drivers following observations and suggestions by Ergonomist during the field evaluation)

6 ELEMENT H 08
RATING
- 2
PROBLEMS
- microphone hook inappropriately placed; operator leaves microphone dangling
REMEDIAL SUGGESTIONS
- relocate microphone hook

Table A-1g

Operator Task I (Administer First Aid and/or Emergency Procedures)

---

1 ELEMENTS I 01/02
RATING
- 1
PROBLEMS
- access of medical provisions (stored on floor, secured with velcro) requires disadvantageous stooping by operator
- unclear which provisions are for administration by operator as first aid, or by paramedics (regular operator is trained in first aid), and whether provisions are adequate in either case
- oxygen tank appears is being replaced with a smaller tank with a regulator
REMEDIAL SUGGESTIONS
- a storage place that does not require stooping is preferable to present arrangement; an overhead compartment is best
- clearly define operator roles as previously noted in Table A-1d, Elements F 05 and G 04; train in additional areas if necessary
- check out adequacy of medical supplies for emergency function with relevant authority (e.g. inflatable leg or body casts, steri wipes, etc.)
- include additional portable mask in medical kit

2 ELEMENTS I 03/04
RATING
- 2
PROBLEMS
- fire extinguisher and flares not readily accessible; operator needs to duck under door lever to reach
- not practical to test operation of fire extinguishers and flares
REMEDIAL SUGGESTIONS
- store fire extinguisher and flares in easily accessible, clearly visible place
- conduct periodic inspections of integrity of materials

Table A-1h

Operator Tasks: J (Administrate Operator Function)
K (Clean and Maintain Mechanical Integrity of Vehicle)

1 ELEMENTS J 01/02
RATING
- 1
PROBLEMS
- no farebox or other accessible place to store fares; existing storage place for papers obscured by door lever mechanism
REMEDIAL SUGGESTIONS
- for short term, provide pocket on back of seat; for longer term, relocate compartment in accessible place in cab

2 TASK K
COMMENTS
- no observations made; recommend attention to operation/vehicle interactions in future design

APPENDIX A-2 RESULTS: PASSENGERS

Table A-2a

Key to Semi-Ambulatory Passenger Task Elements

A	ENTER VEHICLE
	01 ascend lowest step
	02 ascend middle step
	03 ascend upper step
B	AMBULATE DOOR TO SEAT
C	ACCESS SEAT
D	SECURE SEAT BELT
E	RELEASE SEAT BELT
F	EXIT FROM SEAT
G	AMBULATE SEAT TO DOOR
H	EXIT VEHICLE
	01 descend upper step
	02 descend middle step
	03 descend lower step

Table A-2b

Semi-Ambulatory Passenger Tasks

1 ELEMENTS A 01/02/03
H 01/02/03

RATING
- 2

PROBLEMS
- lower step (30 cm) far too high from ground level; step stool made by operator to accommodate passengers has no support, may be unstable on gravel surfaces, may be slippery in wet weather
- rises on steps uneven (30, 19, 20.5 cm), thus putting passenger off pace
- runs not deep enough for firm footing, especially with cold- or wet-weather footwear; reduced further by overhang which risks toe-catching.
- top step uneven
- doorway too narrow (56 cm) for straight-on entry, especially with winter clothing (passengers enter facing sideways); virtually impossible to enter with crutches
- grab rails too small in diameter (12.7 mm), painful to grasp, especially for elderly or arthritic hands; also too short, too sharply angled for good support, and not advantageously placed; rough metal and protruding bolt of door lever, used by passengers instead of grab rails, expose passengers to injury
- padded covering on pole at top step rotates, impairing balance of passengers

REMEDIAL SUGGESTIONS
- system dangerous; those with impaired mobility would more safely board and exit via the lift; but resulting loss of independence experienced by semi-ambulatory, and additional task load for operator, argue for

this alternative as temporary solution only; complete redesign of steps, door, and support system strongly recommended, using expertise in application of anthropometric techniques (as opposed to simple reference to standards)
- nonslip material on wooden step advised in meantime, along with some form of support; protect passenger against dangerous properties of door lever; fasten down padded covering on pole at top

2 TASKS B, G (Ambulate Door to Seat/Ambulate Seat to Door)
RATING
- 2
PROBLEMS
- overhead rail support inappropriate for semi-ambulatory population, as reaching posture impossible for some and unstabilizing for others; tall person may bump head on rail; sharp-edged brackets present hazard

REMEDIAL SUGGESTIONS
- provide stanchions and/or horizontal rail supports between seats; if overhead rail maintained, place off-centre to reduce probability of head bumping by tall person; equip with lower-hanging soft leather straps

3 TASKS C, F (Access Seat/Exit from Seat)
RATING
- 1
PROBLEMS
- no place to stow walking aids or carried-on baggage
- height of seat makes for easy access and exit from seat (but see the following Table A-2c, Item 1 below, re dangling feet problem)
- sharp edge on air-flow vent housing potentially hazardous to passenger

REMEDIAL SUGGESTIONS
- provide overhead compartments for walking aids and other carried-on material
- use air-flow vent housing with rounded corners and edges

4 TASKS D, E (Secure Seat Belt/Release Seat Belt)
RATING
- 2
PROBLEMS
- passengers not wearing belts provided, unclear whether difficulty relates to design or procedure

REMEDIAL SUGGESTIONS
- have operator advise all passengers to wear belts; record difficulties, if any, in complying

---

Table A-2c

Ride Factors: Semi-Ambulatory Passengers

---

1 SEAT COMFORT
RATING
- 2
PROBLEMS
- some passengers cannot avail themselves of good seat and back support because seat too high for short passengers (1.65 m or less); sitting with dangling feet uncomfortable and medically undesirable (because it

impairs circulation - sitting with pelvis rotated and one hip ahead to get foot on floor - as one passenger did - biomechanically undesirable, especially on long trips)

REMEDIAL SUGGESTIONS

- provide retractable footrest

2 GENERAL COMFORT

RATING

- 1

PROBLEMS

- none observed for short trips; no opportunity to observe for long trips

REMEDIAL SUGGESTIONS

- monitor elimination and other physical needs (e.g. motion sickness, effects of prolonged sitting) of passengers on long trips

3 FEELINGS OF SAFETY

RATING

- 2

PROBLEMS

- no concerns regarding safety expressed; however observations indicate passengers at risk because (a) not wearing seat belts; (b) tools and other objects on floor could become flying missiles in event of accident; (c) operator cannot easily reach fire extinguisher

REMEDIAL SUGGESTIONS

- ensure wearing of seat belt; provide safe storage of tools, etc.; relocate fire extinguisher to accessible position

4 SENSATION OF NAUSEA

RATING

- 0

COMMENTS

- motion sickness may be experienced by some passengers, especially if the vehicle is reconfigured to have passengers facing sideways or rearward, and if low-level frequency vibrations (especially 0.15 to 0.25 Hz) are experienced

5 VISIBILITY

RATING

- 1

PROBLEMS

- windows (71 cm from floor, 51 cm high) may be too low for some people, forcing a disadvantageous crooking of the neck to see out

REMEDIAL SUGGESTIONS

- in subsequent models, use anthropometric expertise to determine suitable window heights for adult passengers

6 SEAT CONFIGURATION

RATING

- 0

COMMENTS

- present configuration affords passengers plenty of room for access and exit, gives sensation of spaciousness, and is optimal for lowering the probability of motion sickness; these conditions might not obtain if passenger suggestions to increase seating capacity are acted on

7 AESTHETICS, NOISE, TEMPERATURE, AIR QUALITY

RATING

- 1

PROBLEMS

- vehicle exterior aesthetically pleasing, but interior has cluttered look because of lack of overhead compartments concealing equipment; colours (metallic grey on floor, clinical white on walls) unpleasant; reflections of distorted images in windows and glare from exterior convex mirror make for visually noisy environment
- noise from vehicle squeaks and rattles, and flapping of securement straps, could be annoying on long trips
- air conditioning and heating work quickly, and are effective to rear of vehicle; but passengers severely subject to draft during wheelchair loading because at least two doors open at that time; tinting on windows may not be enough on long trips to prevent glare and heat from sun
- odour of gasoline is detectable

REMEDIAL SUGGESTIONS

- odour of gas and draftiness need attention at this time; other problems of lower priority, as long trips not yet being undertaken; reference to appropriate expertise at time of re-development suggested; on long trips, curtains will provide environmental control against sun and cold, afford privacy, and absorb sound

---

Table A-2d

Loading/Unloading and Ride Factors: Wheelchair Passengers

---

1 COMFORT

RATING

- 2

PROBLEMS

- jerk on lift startup jostles passenger
- serious vertical jolting of passenger present, even on smooth roads; discomfort and pain from constant jolts to intervertebral discs can endure after ride for many wheelchair passengers with spinal problems
- no provision for passenger to transfer to regular seat for greater ride comfort
- comfort of passenger restraint system not tested

REMEDIAL SUGGESTIONS

- diagnose lift problem and correct
- solution to suspension problem must be found
- provide transfer shell for passengers wishing to transfer to regular seat; provide means of securing folded wheelchair within van.
- test comfort of passenger restraint system

2 SENSATION OF MOVEMENT OF WHEELCHAIR

RATING

- 2

PROBLEMS

- passenger will experience movement on lift if brakes not in order, as is often the case
- lateral centrifugal pull experienced as vehicle takes corners
- vertical movement of wheelchair may be occurring

REMEDIAL SUGGESTIONS
- provide wedges or other suitable stop for wheelchair on lift
- check operation of wheelchair securement system

3 FEELING OF SAFETY
RATING
- 2
PROBLEMS
- several factors create feelings of insecurity on lift: (a) startup and stop jerk of lift; (b) passenger does not perceive front wheel guard as footrests protrude; (c) depth perception; (d) movement of chair on lift due to imperfect wheelchair brakes; (e) absence of left-side guard rail
- lack of headrest places passenger at risk during vehicle impact

REMEDIAL SUGGESTIONS
- provide headrest with securement system
- explore possibility of lift system in which operator ascends with passenger; many vehicles with low floors are able to use aluminum ramps instead of lifts

4 SENSATION OF NAUSEA
RATING
- 1
COMMENTS
- see Table A-2c, Item 4, on page 55.
- vertical jolting in vehicle could cause nausea after an hour or so of riding

5 VISIBILITY
RATING
- 2
PROBLEMS
- windows too low; passenger must crook neck to see out

REMEDIAL SUGGESTIONS
- in new vehicle, height of windows should accommodate wheelchair passengers

6 SEAT CONFIGURATION
RATING
- 0
COMMENTS
- location of wheelchair floor mounts has implication mainly for operator

7 AESTHETICS, NOISE, TEMPERATURE, AIR QUALITY
RATING
- 1
PROBLEMS
- see Table A-2c, Item 7, on page 56

Table A-2e

Loading/Unloading and Ride Factors: Stretcher Passengers

1 COMFORT

RATING

- 2

PROBLEMS

- stand-in patient jostled on loading and unloading because of (a) protruding step at rear door; and (b) inexperience of stand-in paramedics
- no discomfort experienced while riding

REMEDIAL SUGGESTIONS

- make step at rear door retractable
- arrange for appropriate training in pairs of at least two local residents to handle emergency function, as well as for periodic practice

2 SENSATION OF MOVEMENT OF STRETCHER IN VEHICLE

RATING

- 0

COMMENT

- though no movement experienced by stand-in subject, crash testing of securement system is nevertheless recommended, if not already carried out

3 FEELING OF SAFETY

RATING

- 1

PROBLEMS

- sense of insecurity experienced while loading/unloading (subject felt secure when riding)

REMEDIAL SUGGESTIONS

- sensations of insecurity relate to inexperience of stand-in subjects; skill of trained personnel will remove problem

4 VIBRATION

RATING

- 0

COMMENTS

- report made on basis of one stand-in subject; factor requires more extensive testing

5 AESTHETICS, NOISE, AIR QUALITY

RATING

- 1

PROBLEMS

- see Table A-2c, Item 7, on page 56

APPENDIX A-3 RESULTS: PARAMEDICS

Table A-3a

Key to Paramedics Task Elements

A	PREPARE STRETCHER	
	01	unload stretcher
	02	disengage leg clip
	03	adjust bed height
		03.1 squeeze/hold controls
		03.2 move bed to position
		03.2.1 intermediate
		03.2.2 high
		03.3 release handles
		03.4 raise/lower to engage lock pins
	04	roll stretcher to patient
B	LOAD PATIENT	
C	ADJUST BACKREST, IF NECESSARY	
	01	support backrest, squeeze lever
	02	release lever to lock
D	ROLL STRETCHER TO VEHICLE	
E	LOAD STRETCHER INTO VEHICLE	
	01	adjust to high inclined
	02	roll, forward (both wheels on floor/undercarriage on bumper)
	03	lift, push stretcher/fold undercarriage
	04	move to position
F	SECURE STRETCHER	
G	ACCESS MEDICAL EQUIPMENT	
H	PLACE MEDICAL EQUIPMENT	
I	ACCESS ATTENDANT'S SEAT	
J	ADMINISTER MEDICAL TECHNIQUES	
K	UNLOAD STRETCHER	
	01	disengage leg clip
	02	pull out of compartment
	03	check undercarriage unfolded
	04	lower transport wheels to ground
	05	roll back to clear loading wheels
	06	lower from inclined level to ground
L	ROLL PATIENT TO DESTINATION	
M	UNLOAD PATIENT	
N	REPLACE STRETCHER	
O	REPLACE MEDICAL EQUIPMENT	

Table A-3b

Paramedics Tasks

1 TASKS A, C, E, F, K, N

RATING

- 2

PROBLEMS

- tests carried out with two stand-in paramedics underscore that preparation of stretcher involves complex maneuvers requiring close coordination of two physically strong, highly-trained individuals

- loading greatly impeded by protruding rear step which gets in way of stretcher handles; inability of right rear door to be fully opened, because of spare tire on back, forces paramedics into nonoptimal position for loading; patient at risk of injury because of bumps and jarrings
- stop on left door buckling; collapse while loading stretcher could be dangerous
- securement system appears to be satisfactory from operational point of view
- storage place for stretcher when not in use uncertain; no blanket with stretcher

REMEDIAL SUGGESTIONS
- designate two local residents and backup persons for emergency function, and train in pairs; practice needed periodically to maintain considerable amount of skill required
- make rear step retractable; find new place for storing spare tire; replace door stops with stronger devices - assume operator (because of high mental load) may try to close doors with stops in place
- decide on storage place for stretcher and equipment including blanket; set up procedures for access

2 TASKS B, M
COMMENTS
- not tested; trained personnel not available

3 TASKS D, L
RATING
- 0

COMMENTS
- roll function appears to be satisfactory but should be tested further with trained personnel

4 TASKS G, H, I, J, O
RATING
- 1

PROBLEMS
- hook mechanisms for glucose and plasma bags function well, but requirements, storage place, and access procedures for some medical equipment uncertain
- attendant swivel seat easily accessed and works well, but not clear whether attendant has enough space to kneel down to administer CPR or other techniques; no kneeling pad

REMEDIAL SUGGESTIONS
- check medical requirements for emergency function (including blanket) with medical emergency authority; establish storage place and access procedures
- test space requirements for administration of medical techniques with actual paramedics; supply kneeling pad

APPENDIX B

SERVICE EVALUATION

INTERVIEW FORMS

MINITONAS HANDIVAN EVALUATION
PERSONAL SERVICE EVALUATION INTERVIEW

Date of Interview: _____ Name of Interviewer: _____

A. During the past two to three weeks what kind of trips have you taken on the Handivan? (Check)

Destinations:	Village	Town	Rural
( ) Work	( )	( )	( )
( ) School	( )	( )	( )
( ) Medical	( )	( )	( )
( ) Shopping	( )	( )	( )
( ) Personal business	( )	( )	( )
( ) Recreation	( )	( )	( )
( ) Other _____(specify)	( )	( )	( )

B. Do you use the Handivan on a regular basis?

( ) Yes _____ times per week
( ) No

_____ times per month

C. How would you travel if the Handivan service was not available?

( ) Drive a car ( ) Walk
( ) Passenger in car ( ) Not able to travel
( ) Taxi ( ) Other _____ (specify)

D. What is your primary reason for using the Handivan?

( ) Weather conditions ( ) Convenience of Handivan service
( ) Car not available ( ) Other (please specify) _____
( ) Cost of taxi service

_____

E. What type of residence do you live in?

( ) Single family ( ) Medical facility
( ) Apartment ( ) Senior citizen's residence

F. Where is your residence located?

( ) Town (Swan River) ( ) Rural
( ) Village of Minitonas ( ) Other (state) _____

G. How many cars are available in your home?

( ) None ( ) One ( ) Two or more
Are any of these equipped with hand controls? ( ) Yes ( ) No

H. How far in advance do you have to arrange to travel?

( ) Same day
( ) 24 hours in advance
( ) Longer (specify number of days) _____

I. Have you had any difficulty arranging for travel?

( ) Yes ( ) No

If yes, what was the problem?

( ) Had trouble getting through on busy phone.
( ) Couldn't get a trip at the time I wanted so I arranged for a different time.
( ) Other (please specify) _____

J. Was the person who recorded your request courteous and helpful?

( ) Yes ( ) No

If no, please explain briefly:

_____

_____

K. On your last trip by Handivan, what was your requested pick-up time and what was your actual pick-up time? (Please circle A.M. or P.M.)

For example: (:) A.M. P.M.

Initial trip to your destination:
Scheduled pick-up time: (:) A.M. P.M.

Actual pick-up time: (:) A.M. P.M.

Return trip home:
Scheduled pick-up time: (:) A.M. P.M.

Actual pick-up time: (:) A.M. P.M.

How long did you ride on the Handivan?

On the initial trip to your destination: _____ minutes

On the return trip home: _____ minutes

L. How do you rate the Handivan service? Please circle the number which best expresses your feeling.

Vehicle comfort:	Good			Poor
(a) Stationary	1	2	3	4
(b) Moving	1	2	3	4
Vehicle cleanliness:	Good			Poor
	1	2	3	4
Dependability of service:	Good			Poor
	1	2	3	4
Ease of entry and exit:	Good			Poor
	1	2	3	4
Convenience of the wheelchair lift:	Good			Poor
	1	2	3	4
Fare charged:	Low			High
	1	2	3	4
Driver courtesy and helpfulness:	Good			Poor
	1	2	3	4
Please rate the driver's attention to safety:	Good			Poor
	1	2	3	4

Do you have any comments as to how we can improve the service presently supplied?

(Interviewer please complete the following:)

Disabilities:

( ) None ( ) Medical

( ) Wheelchair use ( ) Hearing

( ) Walking frame ( ) Vision

( ) Cane ( ) Other (please specify) _____

Sex: ( ) Male ( ) Female

Age: ( ) Under 16 ( ) 45 - 64

( ) 16 - 24 ( ) 65 or more

( ) 25 - 44

Occupation: ( ) Working ( ) Unemployed ( ) Retired

Please check one of the boxes below which estimates total family income:

( ) 0 - 5,000 ( ) 10,000 - 20,000

( ) 5,000 - 10,000 ( ) Over 20,000

INSTRUCTIONS

These forms are designed for personal interviews only. They are not to be left with the person being interviewed. For system passengers, use all four pages. For system advocates who do not ride the Handivan, use pages 3 and 4 only. Page 4 is to be completed by the interviewer without asking questions directly. If more data is needed on an individual, the Municipal Clerk may be able to assist you.

APPENDIX C

GRAPHS OF MONTHLY RIDERSHIP

TRIP PURPOSES AND KILOMETRES

C-1 Graph: Total Monthly Ridership

C-2 Graph: Monthly Ridership by Trip Type

C-3 Graph: Total Monthly Kilometres

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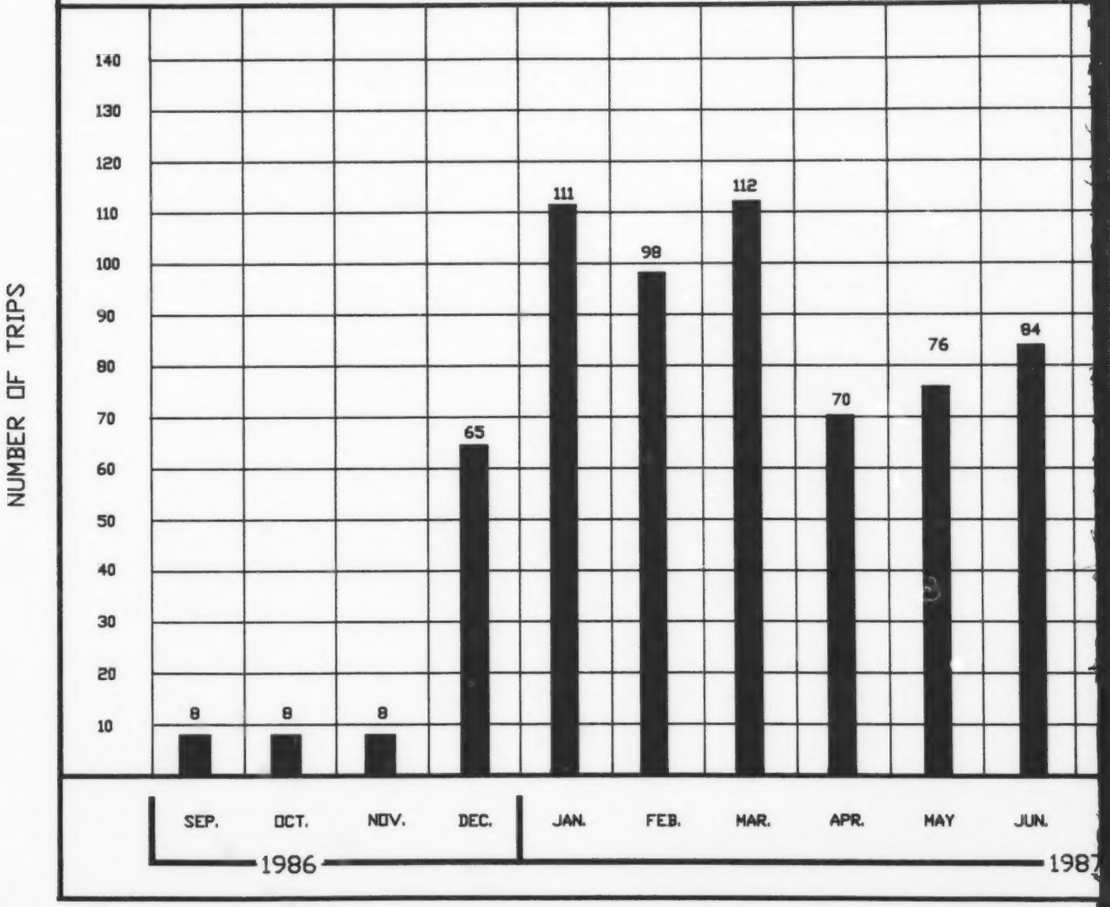
R.M. & VILLAGE O
HANDI–V

TOTAL MONTHLY



LEGEND

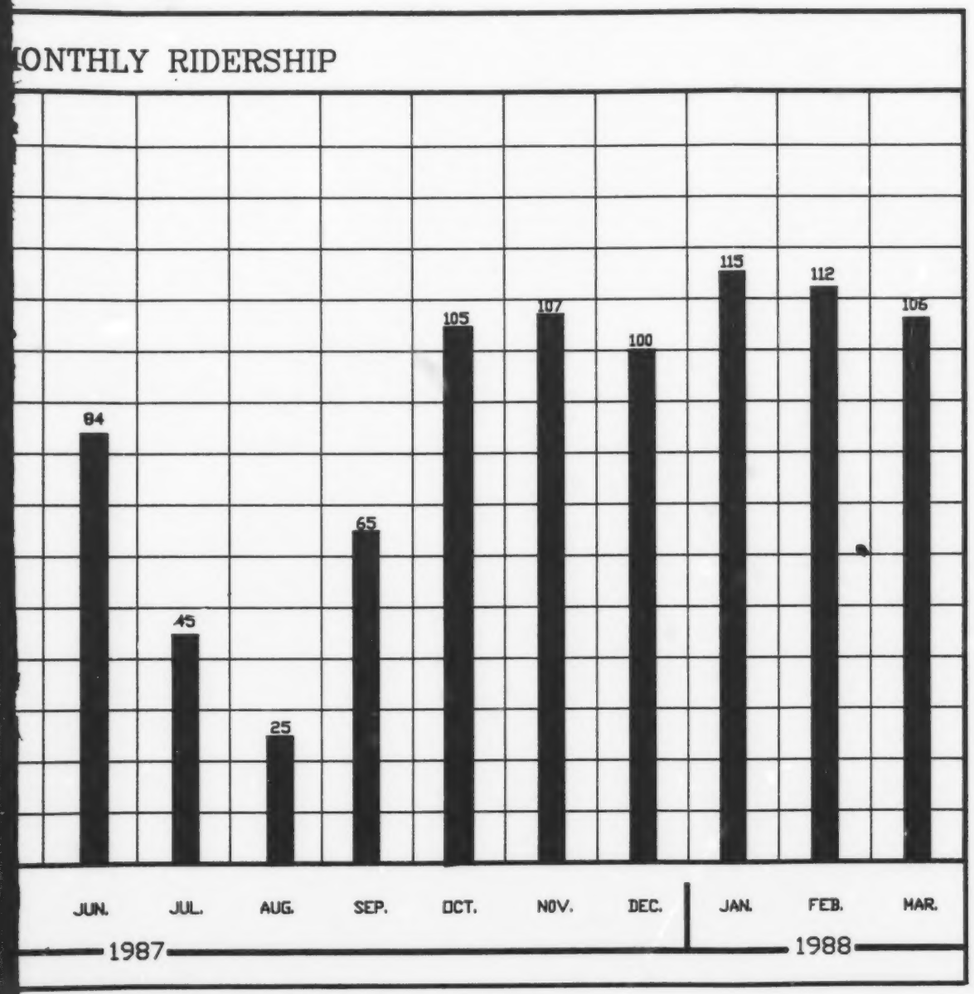
TOTAL OF MONTHLY TRIPS

NOTE:

INFORMATION SUPPLIED BY R.M. & VILLAGE OF MINITONAS HANDI-VAN ASSOCIATION

URAL VEHICLE EVALUATION
LLAGE OF MINITONAS
HANDI–VAN

ONTHLY RIDERSHIP



CONSULTANTS:

- MANOP SERVICES LTD.
- REID CROWTHER & PARTNERS LTD.

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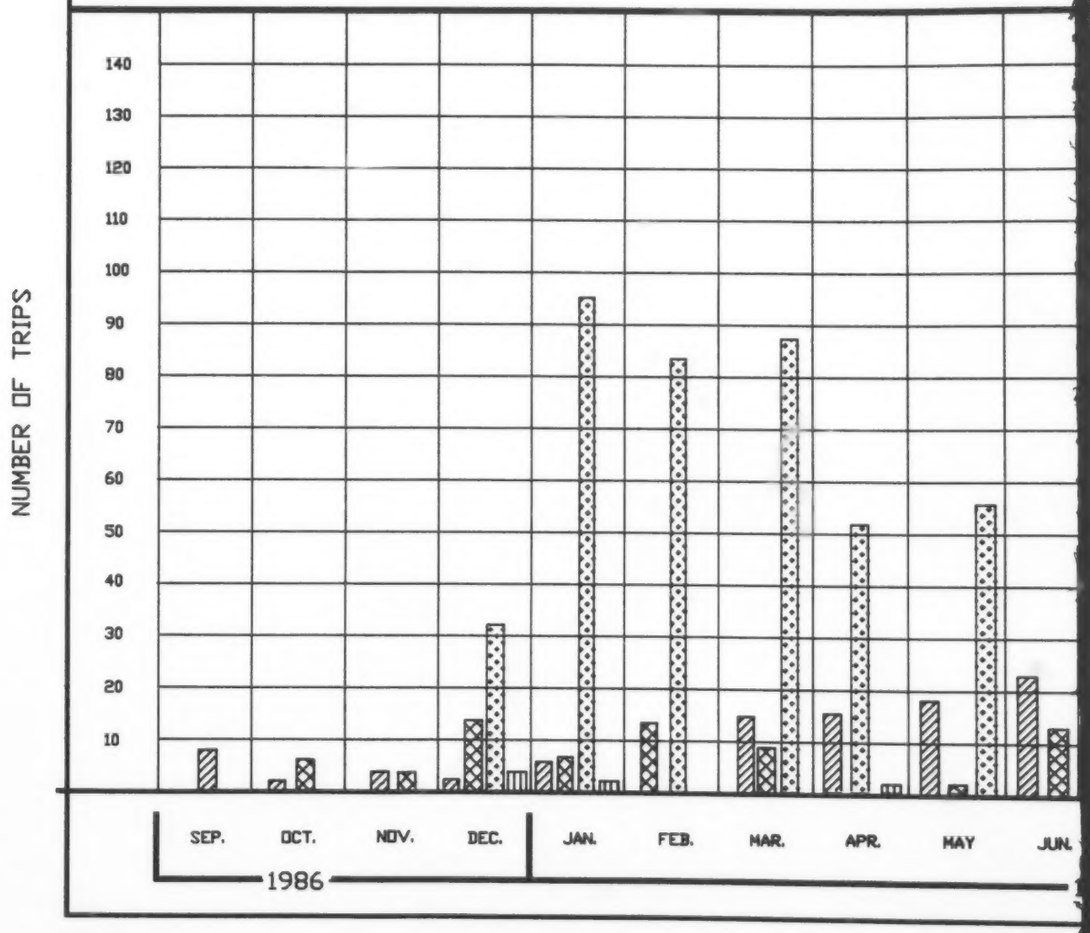


LEGEND

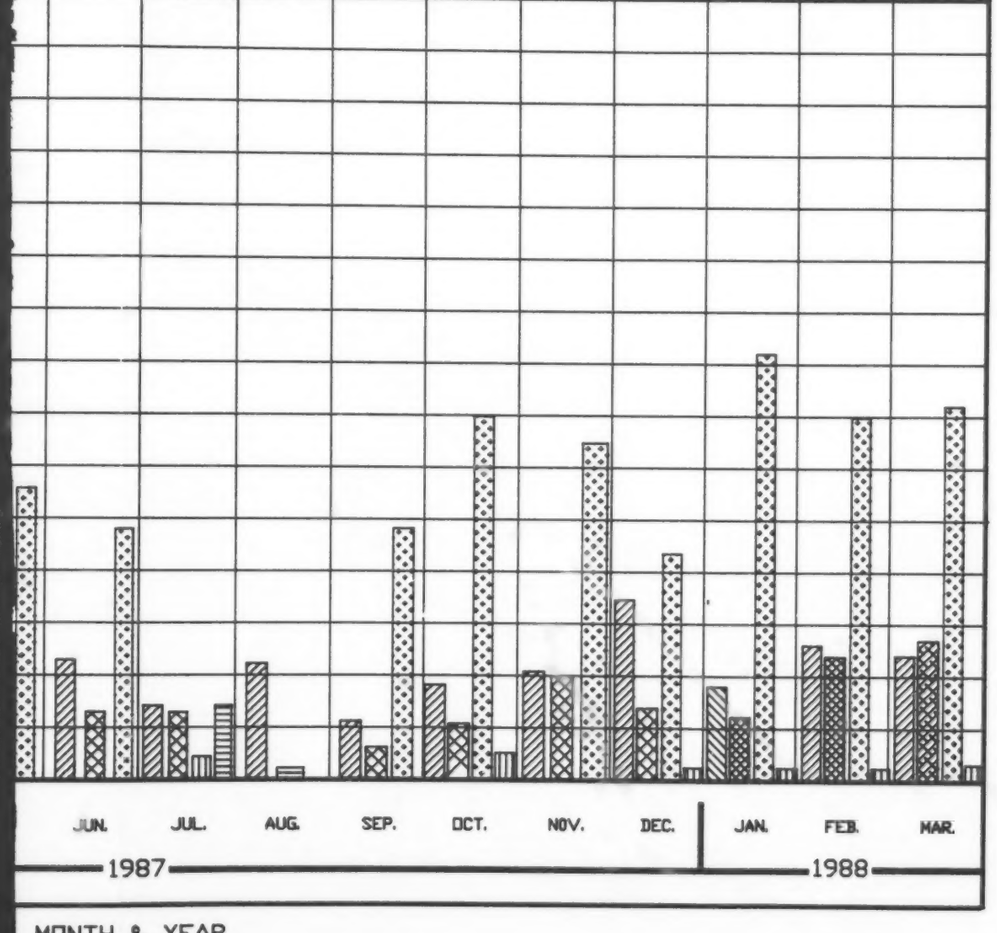
- MEDICAL
- SHOPPING/BUSINESS
- RECREATION
- VISITING
- OTHER

NOTE:

INFORMATION SUPPLIED BY
R.M. & VILLAGE OF MINITONAS HANDI-VAN ASSOCIATION

RURAL VEHICLE EVALUATION
ILLAGE OF MINITONAS
HANDI-VAN

DERSHIP BY TRIP TYPE



CONSULTANTS:

- MANOP SERVICES LTD.
- ECKD CROWTHER & PARTNERS LTD.

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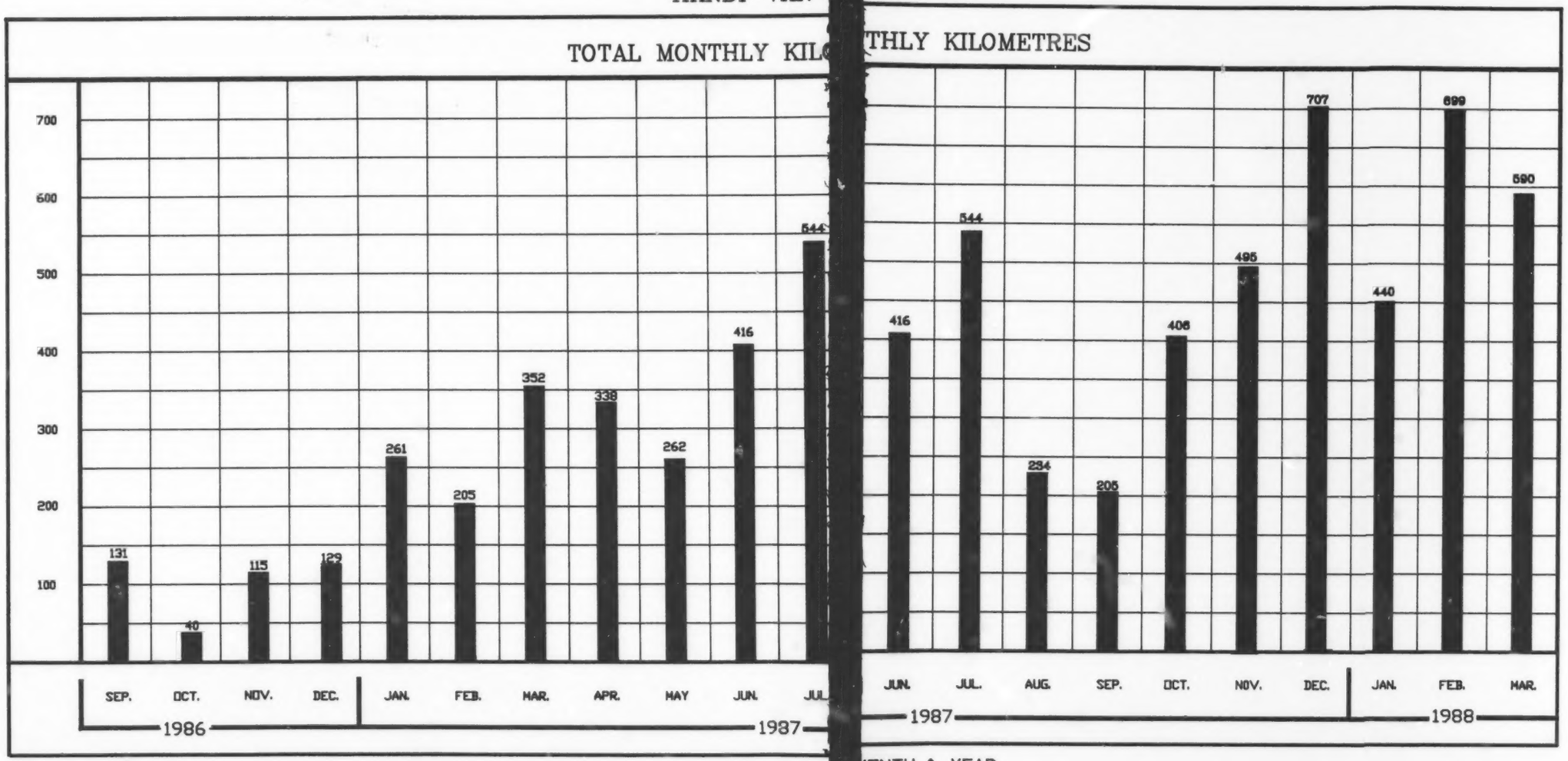

LEGEND

TOTAL MONTHLY MILEAGE

NOTE:

INFORMATION SUPPLIED BY
R.M. & VILLAGE OF MINITONAS HANDI-VAN ASSOCIATION

CONSULTANTS:

- MANOP SERVICES LTD.
- REID CROWTHER & PARTNERS LTD.